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RADAR CROSS SECTION MEASUREMENTS OF THE IMPROVED BQM-34A COLLOCATED AUGMENTATION SCORING SYSTEM

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by

MAURICE R. SMITH

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RATSCAT FACILITY

Radar Target Scatter Division 6585th Test Group (AFSC) Holloman AFB, New Mexico 88330

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FOREWORD

This report is based on actual radar cross section measurements and antenna pattern measurements made at the Armament Development and Test Centers' Radar Target Scatter Division (RAT SCAT) of the 6585th Test Group. RAT SCAT is located on the Alkali Flats, Holloman Air Force Base, New Mexico. This Facility is operated and maintained by Dynalectron Corporation, Radar Backscatter Division, under contract F29601-77-C-0001 and is under the specific direction of the 6585th Test Group. The AF Project Officer is Paul Beavers.

Questions pertaining to the method of test may be addressed to the attention of the 6585th Test Group (RX). Requests for release of this document or related test data must be referred to the Armament Development and Test Center (ADTC/SD102). Eglin Air Force Base, Florida.

This technical report has been reviewed and is approved.

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Chief, Test Operations Branch Radar Target Scatter Division

ABSTRACT

Data were acquired to define the I-band radar cross section and glint characteristics of the Improved BQM-34A CAS (target drone equipped with Collocated active radar Augmentation Scoring System). Monostatic and bistatic radar measurements were made on a flight worthy BQM-34A at the Radar Target Scatter Division (RAT SCAT), 6585th Test Group, Holloman Air Force Base, New Mexico, for the Armament Development and Test Center (ADTC/SD102), Eglin Air Force Base, Florida.

This report provides a summary of the measurement conditions and reproductions of test plots obtained. Also included are reproductions of the antenna gain patterns associated with the digidops scoring system used with the BQM-34A target system.

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SECTION I INTRODUCTION

The BQM-34A target drone has been used for a number of years as a target for test and evaluation of air-to-air and ground-to-air weapons systems. The radar cross section (RCS) of the vehicle is determined by its basic structural configuration, but is not always suitable on the basis of target size.

In order to use the BQM-34A vehicle as an adequate target for modern airborne weapons systems, the radar cross section must be enhanced. This can be accomplished by the use of a radar augmenter to produce RCS values equal to, or exceeding, those of a larger vehicle.

This program consists of three phases: (1) development and testing of an improved augmentation system in brassboard form at RAT SCAT; (2) development of an ultrasonic scale model antenna gain pattern measurement technique by the University of Houston; and (3) verification of the production augmentation system performance in final flight configuration at RAT SCAT.

This report describes the verification testing of the production augmentation system in final flight configuration at RAT SCAT.

SECTION II PURPOSE

The purpose of this program was verification testing of the production augmentation system in final flight configuration. Specifically, the augmentation system performance was to conform to the following RCS performance specifications:

- 1) With the right or left forward augmentation transmitting antenna in operation, augmentation should occur at a minimum level of 30 square meters (14.8 dbsm) throughout a geometrical envelope described by a 30 degree half cone, starboard or port of the vehicle nose.
- 2) With the right or left aft augmentation transmitting antenna in operation, augmentation should occur at a minimum level of 15 square meters (11.8 dbsm) throughout a geometrical envelope described by a 70 degree half cone, starboard or port of the tail of the vehicle.

In addition, antenna gain patterns of the digidops scoring system antennas and some glint data from the augmentation system were obtained.

SECTION III TEST CONDITIONS

Description of Target Vehicle

The vehicle used as a test target on this project was a BQM-34A target drone. Its physical characteristics are: length, 22 feet, 11 inches; wing span, 12 feet, 11 inches; overall height, 6 feet, 8 inches. This particular target drone was equipped with a radar augmentation system and a digidops miss-distance scoring system.

The BQM-34A augmentation system was developed under the direction of the Armament Development and Test Center (ADTC/SD102), Eglin AFB, Florida. The system tested was the Hayes AXA-1/KAI-2, Collocated Augmentation Scoring System (CAS). The basic system configuration and block diagrams have been previously covered in Volume I.

With the appropriate selection of coaxial switch positions, the augmentation system can be remotely operated in four distinct configurations. The fifth and sixth configurations were achieved as a ground changeable option by replacing the coaxial switch in the drone equipment bay with a 3-db power splitter. Identification of the six configurations is listed below:

Configuration No. 1 Forward Receive, Right Forward Transmit

Configuration No. 2 Forward Receive, Left Forward Transmit

Configuration No. 3 Aft Receive, Left Aft Transmit

Configuration No. 4 Aft Receive, Right Aft Transmit

Configuration No. 5 Forward Receive, Right and Left Forward Transmit

Configuration No. 6 Aft Receive, Right and Left Aft Transmit.

The BQM-34A vehicle also contains a digidops scoring system used during flight tests to measure missile-to-target miss-distance on each mission. The interconnect diagram used for antenna pattern measurements of the digidops system is shown in Figure No. 1.

Radar Augmentation System

The purpose of an augmentation system is to enhance the radar crosssection of a target by amplifying and re-transmitting radar signals incident on the target. The radar signals are collected by the receive

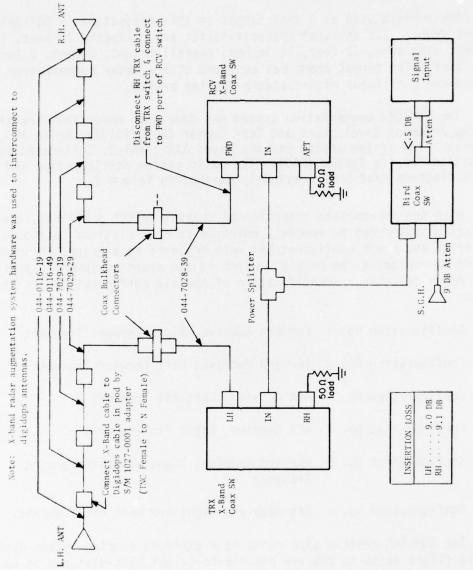


Figure 1 Digidops Antenna Pattern Test Set-Up

antenna selected and then fed through a high pass band-pass filter to the input of the TWT amplifier assembly. The amplified signals are then routed to the appropriate transmitting antenna or antennas for retransmission of the augmented radar signals.

Range Configuration

1. Monostatic RCS Measurements

Data measurement was achieved with a long-pulse radar system operating on a ground plane range. Sections 1 and 2 of Appendix A and Table A-1 of Appendix A summarize the characteristics of RAT SCAT facilities and equipment.

A target being measured on a ground plane range is in an electromagnetic field that is the vector sum of:

- 1) The wave energy that travels directly from antenna to target.
- 2) The wave energy reflected from the surface of the earth.

The vector sum produces an interference pattern at the target. The height of the radar antenna above ground (H_a) is adjusted so that the target is located in the first lobe of the interference pattern at a height (H_t) described by the equation:

$$H_t = \frac{\lambda R}{4 H_a}$$

where λ is the wavelength, and R is the range length.

In order to obtain accurate RCS measurements, the following steps are required:

- Adjust the antenna height and antenna pointing direction for best field uniformity across the volume occupied by the target.
- Tilt the azimuth turntable so the target rotates in the plane of the antenna beam.
- Minimize reflections from target supports, tie-downs and turntable.
- 4) Calibrate the range at the measurement frequency and required polarizations.

Background measurements were made of columns 135A and 135AA in both vertical and horizontal polarizations to confirm minimum interference from the target support columns during monostatic RCS measurements. Representative background levels obtained are shown as Runs Nos. 7 and 8 in the Data Plot Index.

2. Bistatic RCS Measurements

Ten degree and 20 degree bistatic RCS measurements were set up in accordance with the foregoing monostatic measurement techniques, with one major exception; the receiver and transmitting radar antennas were separated from each other by the bistatic angle (10 degrees or 20 degrees as applicable) as illustrated in Figure No. 2.

The correlation of the bistatic data with the pit turntable azimuth is as follows:

- 1) For 10 degree bistatic data at a given target azimuth, the receiving antenna LOS (line of sight) angle is +5 degrees in the direction of turntable rotation from the target azimuth, and the transmitting antenna LOS angle is -5 degrees (in a direction opposite to turntable rotation) from the target azimuth. (See Figure No. 2.) Normal turntable direction of rotation is clockwise looking down on the pit. Turntable azimuths corresponding to this direction of rotation are angles decreasing from 360 degrees to zero degrees.
- 2) Similarly, for 20 degree bistatic data at a given target azimuth, the receiving antenna LOS angle is +10 degrees in the direction of turntable rotation from the target azimuth, and the transmitting antenna LOS angle is -10 degrees (in a direction opposite to turntable rotation) from the target azimuth.

Background measurements were made of columns 135A and 135AA in both vertical and horizontal polarizations to confirm minimum interference for bistatic RCS measurements also. Representative background levels for 10 degree and 20 degree bistatic angles are shown as Runs Nos. 1002, 1003, 2014 and 2015 in the Data Plot Index.

The 9.0 and 10.1 GHz cross section measurement systems were operated with a transmitter pulse width of 0.5 microseconds, a range gate width of 0.2 microseconds, and a pulse repetition frequency of 1 KHz.

The cross section measurement system was calibrated using the broadside specular values of precision metal cylinders. The isotropic gain reference level for the digidops antenna patterns was provided by a Scientific Atlanta Model 12 - 1.7 standard gain horn. Section 3 of

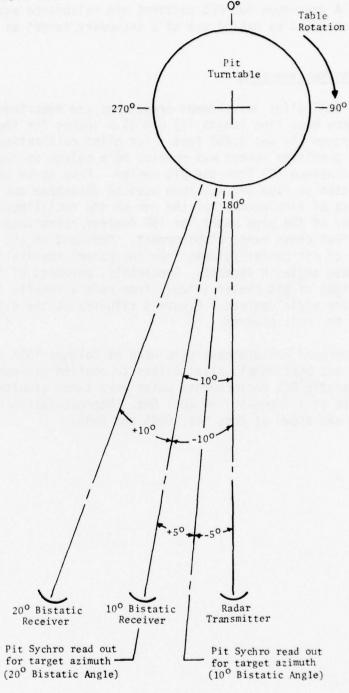


Figure 2

Bistatic Angle Definition

Appendix A describes how RCS patterns are calibrated against a precision primary standard by making use of a secondary target as a transfer standard.

Glint Measurements

RAT SCAT glint measurement procedures are described in Appendix D. The antenna base line length (S) was 51.5 inches for the system used, and the range (R) was 2,458 feet. For glint calibration, a 26.6 inch diameter precision sphere was mounted on a column on the pit and offset a known distance (D) from the pit center. From these known parameters, the equation on Page D-2 was then used to determine and set the number of degrees of displacement of the pen on the rectilinear plot paper. The center of the plot paper, or 180 degrees, represents the pit center, or zero feet cross range displacement. Movement of the test sphere to the left of pit center (viewed from the radar) results in decreasing glint phase angle in degrees. Conversely, movement of the test sphere to the right of pit center (viewed from radar) results in increasing glint phase angle degrees. Figure 3 illustrates the glint measurement geometry for this program.

Background measurements were made of Columns 135A and 135AA in both vertical and horizontal polarizations to confirm minimum interference for monostatic RCS measurements which were taken simultaneously with glint data at a frequency of 10.1 GHz. Representative background levels obtained are shown as Runs Nos. 6005 and 6006.

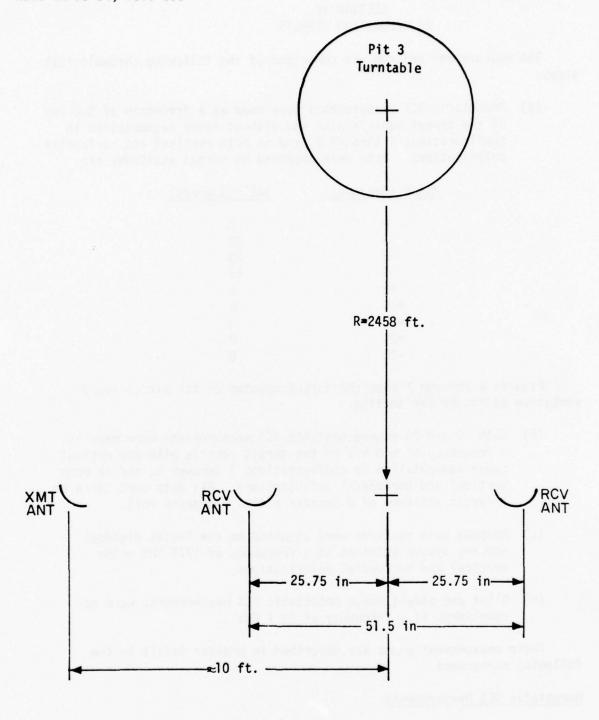


Figure 3

Glint Measurement Geometry

SECTION IV PROCEDURE AND RESULTS

The measurement program was comprised of the following chronological steps:

(a) Monostatic RCS measurements were made at a frequency of 9.0 GHz of the target vehicle with and without radar augmentation in configurations 1 through 6, and in both vertical and horizontal polarizations. Data were obtained at target attitudes of:

Pitch (degrees)	Roll (degrees)
0	0
0	70
0	20
0	45
+5	0
+10	0
+15	0
+20	0
-20	0

Figures 4 through 7 show the target mounted on the pit at representative attitudes for testing.

- (b) Both 10 and 20 degree bistatic RCS measurements were made at a frequency of 9.0 GHz of the target vehicle with and without radar augmentation in configurations 1 through 6, and in both vertical and horizontal polarizations. All data were taken at a target attitude of 0 degrees pitch, 0 degrees roll.
- (c) Antenna gain patterns were acquired on the T-slot digidops scoring system antennas at a frequency of 1775 MHz using vertical and horizontal polarizations.
- (d) Glint and simultaneous monostatic RCS measurements were accomplished at a frequency of 10.1 GHz.

These measurement steps are described in greater detail in the following paragraphs.

Monostatic RCS Measurements

Referring to the Monostatic RCS portion of the Data Plot Index, it will be seen that (except for the background plots) there are three data presentations for each run. These are rectilinear raw data plots,



Figure 4

Target Mounted at 0° Pitch 20° Roll

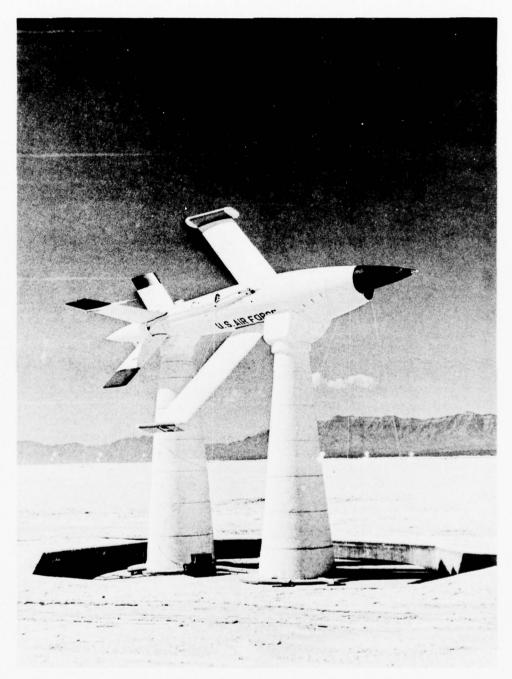


Figure 5 Target Mounted at 0° Pitch 70° Roll (Top View)

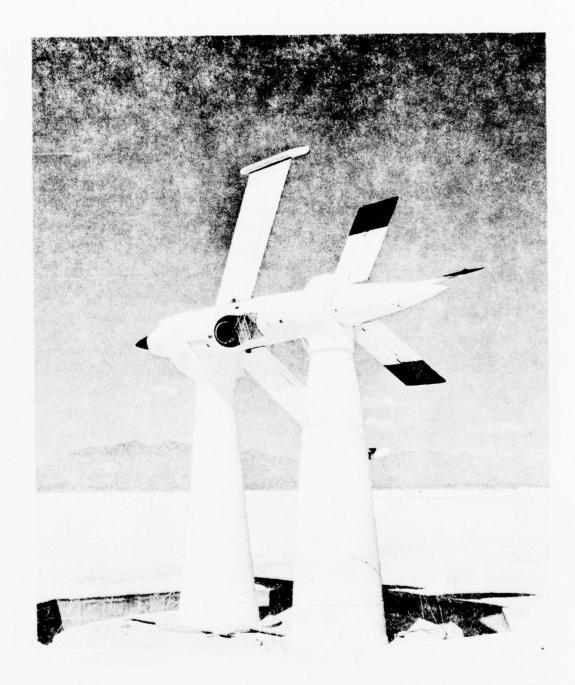


Figure 6 Target Mounted at 0° Pitch 70° Roll (Bottom View)

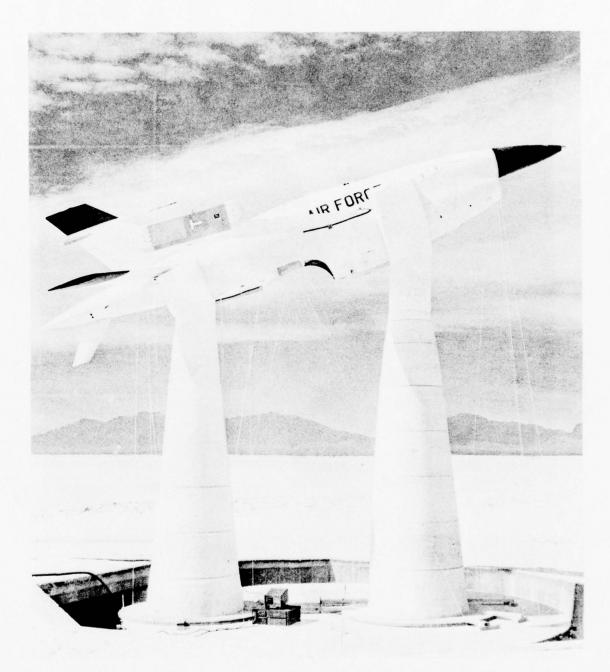


Figure 7

Target Mounted at 0° Roll +15° Pitch

median plots made from raw taped data and polar plots. The Run No. for the median data contains the suffix "M" and the polar plots the suffix "P".

During test runs, the AGC voltage of the augmentation system was monitored. At the customer's direction, attenuation was inserted in the test radar transmitter output to keep this AGC voltage within specified limits (less than +1.0 volt). This insured that the TWT amplifier in the augmentation system was not operating in the saturation area of the tube. The amount of attenuation inserted is listed on the individual data plot title block.

Referring to Section II (performance specifications for the augmentation system) and the monostatic RCS data plots, the data suggests generally that forward radar augmentation performance meets the requirements put upon it. Data would seem to indicate that aft coverage is marginal on output levels but exceeds specifications on angle of coverage; however, it should be pointed out that the TWT specifications allow for +72 dB gain, but for these tests the gain was set to +68 dB by Hayes personnel. It would seem, based on this fact, that the system gain could be set to obtain the specified output for aft antenna output.

The monostatic RCS data are shown as Runs with numbers less than 500 in the Data Plot Index.

Ten Degree and 20 Degree Bistatic RCS Measurements

The bistatic plots, in general, indicate augmentation operation at 10 and 20 degree bistatic angles generated RCS levels equal to or greater than the RCS values of comparable monostatic values. The drone RCS without augmentation was generally less at the bistatic angles as compared to the monostatic values.

It should be remembered when comparing monostatic and bistatic data plots that, although the speculars, etc. occur at similar target azimuth angles on the plots, the target azimuth is actually beyond the radar transmitter LOS azimuth angle (in direction of pit turntable rotation) by one-half the bistatic angle in degrees, and before the radar receiver LOS azimuth angle (in direction opposite to pit turntable rotation) by one-half the bistatic angle in degrees (as illustrated in Figure No. 2).

These data plots (monostatic and bistatic RCS data) give some indication of the directivity of the augmentation system scattering.

The bistatic RCS data are listed in the Data Plot Index. Run Nos. in the 1000 series correspond to 10 degree bistatic angle, and the 2000 series correspond to the 20 degree bistatic angle.

Digidops Antenna Gain Patterns

Measurements of the gain patterns of the T-slot digidops scoring system antennas were performed at a frequency of 1775 MHz using horizontal and vertical polarizations. Data were acquired with pitch angle held at zero degrees and at roll angles of 0, 20, 45 and 70 degrees. Data were also acquired with roll angle at zero degrees and a pitch angle of +20 degrees. The patterns were calibrated with a standard gain horn and are referenced to its isotropic (dBi) level.

It should be noted from Figure No. 1 that a power splitter is used for interconnecting right and left antennas for simultaneous transmission. For switching convenience one port is terminated in a 50 ohm load for single antenna transmission. This means that all single antenna pattern data points are 3 dB low.

Antenna pattern coverage appears to be good. Vertical and horizontal polarization patterns are quite similar at a target attitude of 0 degree roll, 0 degree pitch, but become quite dissimilar in magnitude at higher target roll angles.

The digidops antenna patterns are shown as Runs 500 through 518 in the Data Plot Index. Polar plots only were provided for these data.

Glint Measurements

The glint data requirement was added to the program and was accomplished at a frequency of 10.1 GHz. Monostatic RCS data were taken also, primarily as an aid to range personnel while gathering glint data. These data are also included, although they are somewhat redundant to already-described monostatic RCS data.

The most significant observation to be made from the glint data is the intense glint activity during augmentation operation, which would seem to aid target survival against unsophisticated radar guided attacks on it.

All glint data were taken at 0.01 degree azimuth increments, whereas all other data for this project were taken at 0.1 degree azimuth increments.

The glint data are shown as Runs with 6000 series numbers on the Data Plot Index.

The glint plots have a "G" following the run number on the individual data blocks to help distinguish them from the monostatic RCS plots with the same run number.

The glint plots are in glint phase degrees versus target azimuth in degrees. The conversion to apparent feet displacement of the target from pit center (and 180 degrees on the plots) is 0.2 foot per degree of glint. As previously explained, glint phase angles less than 180 degrees represent apparent displacement to the left of pit center (viewed from radar) and angles greater than 180 degrees represent displacement to the right of pit center.

CONT	CONTROL NUMBER	UMBER	77-32		Table I	DATA PLOT INDEX Sheet 1
PAGE NO.	RUN	FREQ (MHz)	POLARI- ZATION	PITCH ANGLE	ROLL	TARGET CONFIGURATION AND REMARKS
						MONOSTATIC RCS
32	7	0006	壬	N/A	N/A	Background, Columns and Transitions (Typical)
33	8	0006	٨	N/A	N/A	Background, Columns and Transitions (Typical)
34	6	0006	۸۸	00	00	Aug. Off
35	W6	0006	۸۸	0	0	Median
36	d6	0006	^	0	0	Polar
37	10	0006	壬	0	0	Aug. Off
38	10M	0006	Ħ	0	0	Median
39	10p	0006	#	0	0	Polar
40	11	0006	Ŧ	0	0	Aug. On. Configuration No. 1
41	MLL	0006	#	0	0	Median
42	dll	0006	王	0	0	Polar
43	12	0006	۸۸	0	0	Aug. On, Configuration No. 1
44	12M	0006	٨٨	0	0	Median
45	12P	0006	۸۸	0	0	Polar
46	13	9000	۸۸	0	0	Aug. On, Configuration No. 2
47	13M	0006	۸۸	0	0	Median
48	13P	0006	۸۸	0	0	Polar
49	14	0006	王	0	0	Aug. On. Configuration No. 2
20	14M	0006	±	0	0	Median
51	14P	9000	HH	0	0	Polar
52	15	9000	#	0	0	Aug. On, Configuration No. 3
53	15M	0006	Ħ	0	0	Median
54	15P	0006	HH	0	0	
25	16	0006	۸۸	0	0	Aug. On, Configuration No. 3
99	16M	0006	۸۸	0	0	Median
57	16P	0006	W	0	0	Polar
28	17	0006	۸۸	0	0	Aug. On, Configuration No. 4
29	17M	0006	Λ	0	0	Median
09	17P	0006	Λ	0	0	Polar
[9]	18	0006	Ħ	0	0	Aug. On, Configuration No. 4
62	18M	0006	Ħ	0	0	Median

RBD 72 - 007

CONT	TROL N	CONTROL NUMBER _	77-32 POLABI-	РІТСН	Table I	DATA PLOT INDEX Sheet 2
NO.	RUN	(MHz)	ZATION	ANGLE	ANGLE	TARGET CONFIGURATION AND REMARKS
63	18P	0006	垄	0	0	Polar
64	539	0006	壬	0	0	Aug. On, Configuration No. 5
65	299M	0006	壬	0	0	Median
99	299P	0006	壬	0	0	Polar
29	300	0006	W	0	0	Aug. On, Configuration No. 5
89	300M	0006	W	0	0	Median
69	300P	0006	W	0	0	Polar
70	301	0006	W	0	0	Aug. On, Configuration No. 6
71	301M	0006	٨٨	0	0	Median
72	301P	0006	٨٨	0	0	Polar
73	302	0006	壬	0	0	Aug. On, Configuration No. 6
74	302M	0006	壬	0	0	Median
75	302P	0006	丑	0	0	Polar
9/	21	0006	W	0	70	Aug. Off
11	21M	0006	W	0	70	Median
78	21P	0006	٨	0	70	Polar
79	22	0006	壬	0	70	Aug. Off
80	22M	0006	₹	0	70	Median
81	22P	0006	₹	0	70	Polar
82	23	0006	壬	0	70	Aug. On, Configuration No. 1
83	23M	0006	₹	0	70	Median
84	23P	0006	圭	0	70	Polar
85	24	0006	W	0	70	Aug. On. Configuration No. 1
98	24M	0006	٨٨	0	70	Median
87	24P	0006	٨٨	0	70	Polar
88	25	0006	۸۸	0	70	Aug. On, Configuration No. 2
83	25M	0006	۸۸	0	70	Median
8	25P	0006	٨	0	70	Polar
16	92	0006	₹	0	70	Aug. On, Configuration No. 2
92	26M	0006	壬	0	70	Median
93	26P	0006	±	0	70	Dolan

DATA PLOT INDEX Sheet 3	TARGET CONFIGURATION AND REMARKS	Aug. On, Configuration No. 3	Median	- 1	Aug. On, Configuration No. 3	Median	Aug. On. Cenfiguration No. 4		Polar	Aug. On, Configuration No. 4	Median	Polar	Aug. On, Configuration No. 5	Median	Polar	Aug. On, Configuration No. 5	Median	Polar	Aug. On, Configuration No. 6	Median	Polar	Aug. On, Configuration No. 6	Median	Polar	Aug. Off	Median	Polar	Aug. Off	Median	Polar
e I	ROLL		1	1																-			1							
Table I	ROAN	70	70	70	70	0 2	2	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	20	20	20	50	20	20
Tab1	PITCH RO ANGLE AN		+	+	+	+	0 70												-					+			0 20			
77-32. Tabl	CH	0	+	0	+	0	+	0	0	0		0	0	0	0	0	0		0		0	0	0	0		0		0	0	c
77-32	DOLARI- PITCH ZATION ANGLE	0 ##	0	0 HH	0 //	O O	0	0 //	0 ^/	0 HH	0	0 НН	0 HH	0 HH	O HH	0 ^/	0 0	0 //	0 //	0	0 0	O ±	0 HH	0 #	0	0 #	O HH	0 M	0 0	c
	POLARI- PITCH ZATION ANGLE	0 нн 0006	0 HH	0 HH 0006	0 //	0 AA 0006) O	0 ΛΛ 0006	0 000 NA 0006	0 HH 0006	0 HH	0 нн 0006	0 нн 0006	0 HH 0006	0 HH 0006	0 ^/	0 AA 0006	0 00 AA 0006	0 //	0 AA 0006	0 AA 0006	0 HH 0006	0 HH 0006	0 НН 0006	0 #	0 HH 0006	O HH	0 AA 0006	0 AA 0006	ο ΛΛ 0006

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DATA PLOT INDEX Sheet 4	TARGET CONFIGURATION AND REMARKS	Aug. On. Configuration No. 1	Median	Polar	Aug. On, Configuration No. 1	Median	Polar	Aug. On. Configuration No. 2	Median	Polar	Aug. On, Configuration No. 2	Median	Polar	Aug. On, Configuration No. 3	Median	Polar	Aug. On, Configuration No. 3	Median	Polar	Aug. On, Configuration No. 4	Median	Polar	Aug. On, Configuration No. 4	Median	Polar	Aug. Off	Median	Polar	Aug. Off	Median	Polar	
Table I	ROLL	20°	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	45	45	45	45	45	45	The second second second second
	PITCH ANGLE	00	0	0	0	0	0	0	0	0	0	0	0	c	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	The second secon
11-32	POLARI- ZATION	۸۸	۸۸	۸۸	Ŧ	HH	₹	Ħ	Ħ	壬	۸۸	M	٨٨	٨٨	۸۸	Λ	Ŧ	圭	₹	₹	₹	Ŧ	۸۸	۸۸	۸۸	۸	W	۸۸	HH	HH	±	The second second
IMBER	FREQ (MHz)	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	-
CONTROL NUMBER	RUN	219	219M	219P	220	220M	220P	221	221M	221P	222	222M	222P	223	223M	223P	224	224M	224P	225	225M	225P	526	226M	226P	227	227M	227P	228	228M	228P	
CONT	PAGE NO.	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	

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DATA PLOT INDEX Sheet 5	TARGET CONFIGURATION AND REMARKS	Aug. On, Configuration No. 1	Median	Polar	Aug. On, Configuration No. 1	Median	Polar	Aug. On, Configuration No. 2	Median	Polar	Aug. On, Configuration No. 2	Median	Polar	Aug. On, Configuration No. 3	Median	Polar	Aug. On, Configuration No. 3	Median	Polar	Aug. On, Configuration No. 4	Median	Polar	Aug, On, Configuration No. 4	Median	Polar	Aug. On, Configuration No. 5	Median	Polar	Aug. On, Configuration No. 5	Median	Polar	
Table I	ROLL	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	45	
	PITCH	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C	
77-32	POLARI- ZATION	₹	壬	壬	λλ	۸۸	^	^^	۸۸	٨	壬	圭		壬	壬	Ŧ	٨	٨	۸۸	٨٨	٨	٨٨	₹	壬	壬	픞	壬	圭	٨٨	۸۸	۸۸	
CONTROL NUMBER	FREQ (MHz)	9000	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	9000	0006	0006	0006	0006	
SOL NI	RUN	229	229M	229P	236	236M	236P	231	231M	231P	230	230M	230P	233	233M	233P	232	232M	232P	235	235M	235P	234	234M	234P	309	309M	309P	310	310M	310P	
-								_		_	-	-	-	-	-	_	_		-						_					-	-	

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DATA PLOT INDEX Sheet 6	TARGET CONFIGURATION AND REMARKS	Aug. On, Configuration No. 6	Median	Polar	Aug. On, Configuration No. 6	Median	Polar	Aug. Off	Median	Polar	Aug. Off	Median	Polar	Aug. On, Configuration No. 1	Median	Polar	Aug. On, Configuration No. 1	Median	Polar	Aug. On, Configuration No. 2	Median	Polar	Aug. On, Configuration No. 2	Median	Polar	Aug. On, Configuration No. 3	Median	Polar	Aug. On, Configuration No. 3	Median	Polar
Table I	ROLL	45	45	45	45	45	45	0	0	0	0	Ú	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PITCH ANGLE	0	0	0 -	0	0	0	2	5	2	2	5	5	5	5	5	5	5	5	5	5	5	2	2	2	2	5	5	5	5	2
77-32	POLARI- ZATION	٨	٨	٨٨	壬	壬	壬	M	٨	٨	Ŧ	壬	壬	Ħ	Ħ	Ŧ	٨٨	۸	۸۸	٨٨	٨٨	^	圭	₹	壬	₹	HH	Ħ	٨	۸۸	٨٨
JMBER	FREQ (MHz)	0006	0006	9000	0006	0006	0006	0006	0006	0006	0006	0006	0006	9000	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006
CONTROL NUMBER	RUN	311	311M	3119	312	312M	312P	249	249M	249P	250	250M	250P	247	247M	247P	248	248M	248P	252	252M	252P	251	251M	251P	253	253M	253P	254	254M	254P
CONT	PAGE NO.	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	506	207	208	209	210	211	212	213

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DATA PLOT INDEX Sheet 8	TARGET CONFIGURATION AND REMARKS	Aug. On, Configuration No. 4	Median		Aug. On, Configuration No. 4	Hedian	Polar	Aug. Off	Median	Polar	Aug. Off	Median		Aug. On, Configuration No. 1	Median	Polar	Aug. On, Configuration No. 1	Median		Aug. On, Configuration No. 2	Median	Polar	Aug. On, Configuration No. 2	Median		Aug. On, Configuration No. 3	Median		Aug. On, Configuration No. 3	Median	Polar
Table I	ROLL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PITCH	10	10	10	10	10	0	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15
77-32	POLARI- ZATION	٨	۸	٨	壬	Ŧ	王	W	W	٨	₹	壬	₹	Ŧ	Ŧ	壬	۸۸	W	٨	۸۸	٨٨	W	Ŧ	Ŧ	₹	풒	Ħ	₹	۸۸	۸۸	A
CONTROL NUMBER	FREQ (MHz)	0006	0006	0006	0006	0006	0006	0006	9000	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006
ROL N	RUN	265	265M	265P	566	266M	266P	569	269M	269P	270	270M	270P	172	271M	271P	272	272M	272P	273	273M	273P	274	274M	274P	275	275M	275P	276	276M	276P
1 5	PAGE NO.			9	7	248	6	0	_	2	3	4	2	9	7	8	6	0	_	2	3	4	5	9	1	8	569	0	_	2	3

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DATA PLOT INDEX Sheet 9	TARGET CONFIGURATION AND REMARKS	Aug. On, Configuration No. 4	Median	- 1	Aug. On, Configuration No. 4	Median	Polar	Aug. Off	Median	Polar	Aug. Off	Median	Polar	Aug. On, Configuration No. 5	Median	Polar	Aug. On, Configuration No. 5	Median	Polar	Aug. On, Configuration No. 6	Median	Polar	Aug. On, Configuration No. 6	Median	Polar	Aug. Off	Median	Polar	Aug. Off	Median	Polar	
	L E																															
Table I	ROLL	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	C	0	0	0	0	С	0	С	С	0	
Table I	PITCH ROL ANGLE ANGI		15 0		15 0									20 02																		
77-32 Table I		15		15	15	15	15	20	. 20	20	20	20		20	20		20	20	20	20	20	20	20	20	20	-20	-20	-20	-20	-20	-20	
77-32	- PITCH ANGLE	VV 15	15	VV 15	HH 15	HH 15	HH 15	НН 20	HH 20	HH 20	VV 20	vv 20	20	VV 20	VV 20	20	HH 20	HH 20	нн 20	HH 20	HH 20	НН 20	VV 20	VV 20	VV 29	VV ~20	VV -20	VV -20	-20	HH -20	HH -20	
	POLARI- PITCH ZATION ANGLE	9000 VV 15	9000 VV 15	9000 VV 15	9000 HH 15	9000 HH 15	9000 HH 15	9000 нн 20	9000 HH 20	9000 HH 20	9000 VV 20	9000 vv 20	VV 20	9000 VV 20	9000 vv 20	9000 VV 20	9000 нн 20	9000 НН 20	9000 нн 20	9000 нн 20	9000 нн 20	9000 нн 20	9000 VV 20	9000 VV 20	9000 VV 20	9000 VV -20	9000 vv -20	9000 VV -20	9000 нн -20	9000 HH -20	9000 HH -20	

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DATA PLOT INDEX Sheet 10	TARGET CONFIGURATION AND REMARKS	Aug. On, Configuration No. 5	Median	Polar	Aug. On, Configuration No. 5	Median	Polar	Aug. On, Configuration No. 6	Median	Polar	Aug. On, Configuration No. 6	Median	Polar	10° BISTATIC RCS	Background, Columns and Transitions (Typical)	Background, Columns and Transitions (Typical)	Aug. Off	Median	Polar	Aug. Off	Median	Polar	Aug. On. Configuration No. 1	Median	Polar	Aug. On. Configuration No. 1	Median	Polar	Aug. On, Configuration No. 2	Median	Polar	
Table I	ROLL	0	0	0			0	0	0		0		0		0	0	0	0		0	0	0					0		0		0	
	PITCH ANGLE	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20	-20		0	C	0	0	0	0	0	0	0	0	0	U	0	0	0	0	0	
77-32	POLARI- ZATION	Ŧ	壬	Ŧ	^^	۸۸	۸۸	۸۸	۸۸	۸۸	壬	壬	₹		壬	W	٨٨	۸۸	۸۸	Ŧ	Ŧ	圭	HH	Ħ	HH	٨٨	۸۸	۸۸	۸۸	۸	٨٨	
CONTROL NUMBER	FREQ (MHz)	0006	0006	0006	0006	9000	0006	0006	0006	0006	0006	0006	0006		0006	0006	0006	9000	0006	0006	0006	0006	0006	0006	9000	0006	0006	0006	0006	0006	0006	
ROL N	RUN	293	293M	293P	294	294M	294P	291	291M	291P	292	292M	292P		1002	1003	1004	1004M	1004P	1005	1005M	1005P	1019	M6101	d6101	1018	1018M	1018P	1017	MZ101	1017P	
CONT	PAGE NO.	304	305	306	307	308	309	310	311	312	313	314	315		316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	

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POI	ТРВЕО РОТАВІ- (МНZ) ЗАТІОN 9000 НН 9000 НН 9000 НН 9000 НН 9000 ИН 9000 ИИ 9000 ИИ <t< th=""><th>Table I DATA PLOT INDEX Sheet 11</th><th>ROLL ANGLE</th><th>+-</th><th>1</th><th>0 Polar</th><th></th><th>0 Median</th><th>0 Polar</th><th></th><th>Median</th><th>0 Polar</th><th>0 Aug. On, Configuration No. 4</th><th>0 Median</th><th>0 Polar</th><th>0 Aug. On, Configuration No. 4</th><th></th><th>0 Polar</th><th>AAA AIRIBARA AAA</th><th>20° BISIALIC RUS</th><th>Background, Columns and Iransitions</th><th>-</th><th></th><th>0 Median</th><th>0 Polar</th><th>0 Aug. Off</th><th>0 Median</th><th>0 Polar</th><th>0 Aug. On, Configuration No. 1</th><th>0 Median</th><th>Polar</th><th>0 Aug. On, Configuration No. 1</th><th>0 Median</th></t<>	Table I DATA PLOT INDEX Sheet 11	ROLL ANGLE	+-	1	0 Polar		0 Median	0 Polar		Median	0 Polar	0 Aug. On, Configuration No. 4	0 Median	0 Polar	0 Aug. On, Configuration No. 4		0 Polar	AAA AIRIBARA AAA	20° BISIALIC RUS	Background, Columns and Iransitions	-		0 Median	0 Polar	0 Aug. Off	0 Median	0 Polar	0 Aug. On, Configuration No. 1	0 Median	Polar	0 Aug. On, Configuration No. 1	0 Median
77-32 POLARI- PITCH ZATION ANGLE HH 0 0 HH 0 0 WW 0	ROL NUMBER 77-32 RUN (MHz) ZATION ANGLE 1016 9000 HH 0 1015 9000 HH 0 1008 9000 HH 0 1008 9000 HH 0 1008 9000 WW 0 1007 9000 WW 0 1007 9000 WW 0 1006 9000 HH 0 1006 9000 HH 0 1006 9000 HH 0 1007 9000 HH 0 1006 9000 WW 0 1007 9000 HH 0 1006 9000 HH 0 1006 9000 HH 0 1006 9000 HH 0 1006 9000 WW 0 1006 9000 HH 0 2015 9000 HH 0 2002 9000 HH 0 2003 9000 WW 0 2004 9000 WW 0 2004 9000 WW 0 2004 9000 WW 0 2005 9000 HH 0 2005 9000 WW 0 2005 9000 HH 0 2005 9000 HH 0 2005 9000 WW 0		LL	Aug. On,	Median		Aug. On,			Aug. On.	Median		Aug. On,							+		-							Aug. On,		Polar	Aug. On,	
77-32 POLARI- ZATION HH	ROL NUMBER 77-32 RUN (MHz) 2ATION 1016 9000 HH 11015 9000 HH 11008 9000 WW 1008P 9000 WW 1008P 9000 WW 1006 9000 WW 1006 9000 WW 1006 9000 WW 1006 9000 HH 11006 9000 WW 1006 9000 HH 11006 9000 WW 1006 9000 HH 11006 9000 WW 2002 9000 HH 2002 9000 HH 2003 9000 WW 2003 9000 WW 2003 9000 WW 2003 9000 WW 2004 9000 WW 2004 9000 WW 2004 9000 WW 2004 9000 WW 2005 9000 HH 20003 9000 WW 2004 9000 WW 2005 9000 HH 20003 9000 WW 2004 9000 WW 2005 9000 HH 20003 9000 WW 2005 9000 WW 2005 9000 HH 20005 WW 2005 9000 HH	Tabl	CH	+-	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	0	0	0	0	0	0	0	0	0	0	0	0
FREQ (MHz) 9000 9000 9000 9000 9000 9000 9000 90	RUN 1016 1016 1016 1016 1008 1008 1008 1008	77-32		+	壬	Ŧ	王	₹	 	ΛΛ	٨٨	۸۸	W	۸۸	٨٨	Ŧ	₹	H			٨٨	₹	±	±	Ŧ	٨	^/	^	۸	W	^	±	壬
	RUN 1016M 1016M 1016M 1016M 1015M 1008M 1008M 1008M 1006M 1006M	1	FREQ (MHz)	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006								0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006	0006

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PAGE RUN NO. 362 2006 363 2006 364 2006 365 2007 366 2007 366 2007 367 2007 368 2008 370 2008 371 2009 371 2009 372 2009 373 2009 374 2010 375 2010 376 2010 376 2010 378 2011 378 2011 378 2011 378 2011 378 2011 378 2013 378 2013 378 2013 378 2013 378 2013 378 2013 378 2013 378 2013 378 2013 378 2013 378 2013 378 2013		POLL ZATI	PITCH ANGLE 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	ROLL ANGLE O 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	DATA PLOT INDEX Sheet 12 Aug. On, Configuration No. 2 Median Polar Aug. On, Configuration No. 3 Median Polar Aug. On, Configuration No. 3 Median Polar Aug. On, Configuration No. 4 Median Polar Antenna El Antenna LH Antenna LH Antenna Both Antenna
+		Ξ>	00	202	LH Antenna LH Antenna
++++	515P 1775 516P 1775 517P 1775 518P 1775	> = =>	0000	70 70 70 70	RH Antenna RH Antenna Both Antennas Both Antennas

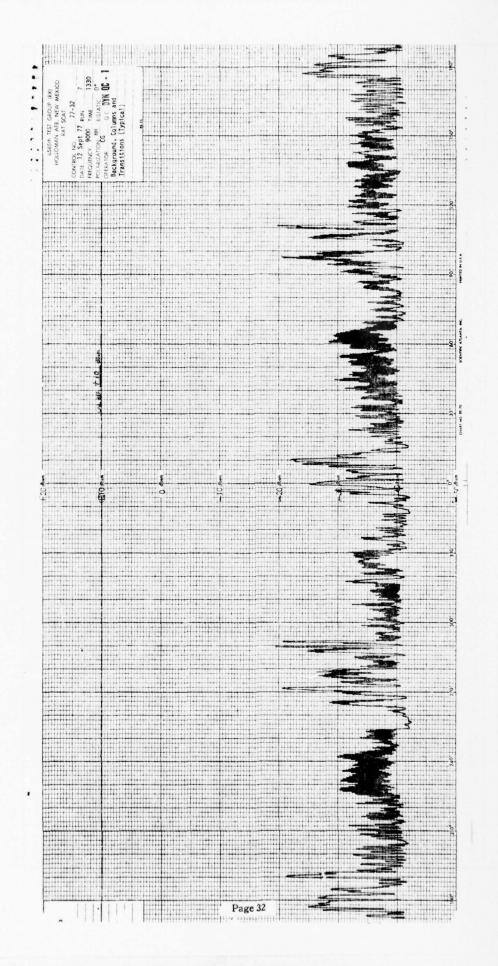
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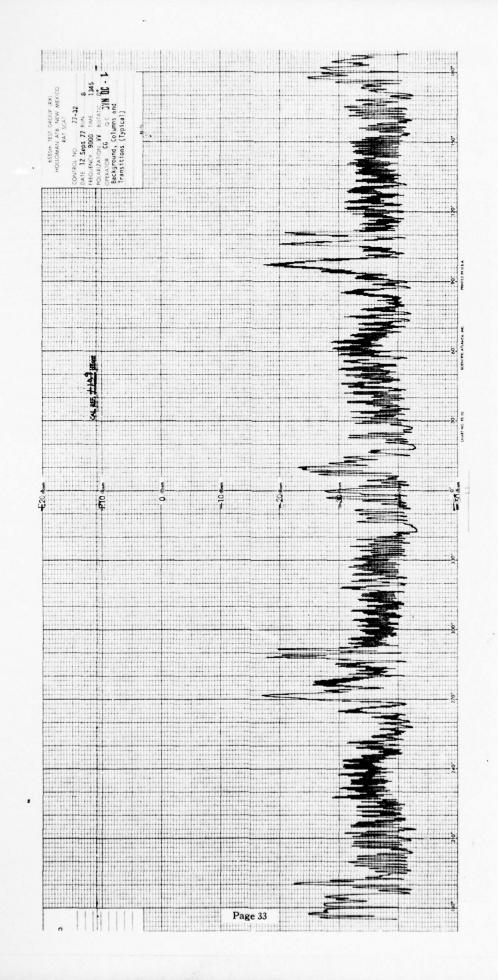
DATA PLOT INDEX Sheet 13	TARGET CONFIGURATION AND REMARKS	LH Antenna	GI INT AND MONOSTATIC RCS	Background, Columns and Transitions (Typical)	Columns and Tra	On, Configuration No.	J. On, Configuration No. 5	. On, Configuration No. 5	On, Configuration No.	. On, Configuration No.	. On, Configuration No. 6	On, Configuration No.	On, Configuration No.	. 0n	On, Configuration No.	. On, Configuration No.	. On, Configuration No.	On, Configuration No.	On, Configuration No.	On, Configuration No.		On, Configuration No.		On, Configuration No.	On, Configuration No.		Aug. On, Configuration No. 6					
I		LH /	1	Bac	Bac	Aug.	Aug.	Aug.	Aug.	Aug	Aug.	Aug	Aug	Aug	Aug.	Aug	Aug	Aug.	Aug.	Aug.	Aug.	Aug.	Aug.	Aug.	Aug.	Aug	Aug					
Table I	ROLL	20	20	45	45	0	0		N/A	N/A	0	0	0	0	0	0	0	0	20	70	70	70	70	70	70	70	45	45	45	45	45	45
	PITCH ANGLE	0	0	0	0	10	10		N/A		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
77-32	POLARI- ZATION	>	Ξ	H	>	^	Ŧ		W	壬	壬	壬	W	۸۸	۸۸	۸۸	壬	Ħ	Ħ	표	۸۸	۸۸	۸۸	۸۸	HH	壬	풒	圭	۸۸	۸۸	٨٨	^
MBER	FREQ (MHz)	1775	1775	1775	1775	1775	1775		10100	10100	10100	10100	10100	10100	10100	10100	10100	10100	10100	10100	10100	10100	10100	10100	10100	10100	10100	10100	10100	10100	10100	10100
CONTROL NUMBER	RUN	508P	507P	510P	509P	512P	511P	1	6009	9009	6043	60436	6042	60426	6044	60446	6009	96009	6021	60216	6022	60226	6041	60416	6040	60406	6039	96809	6038	60386	6037	60376
CONT	PAGE NO.	392	393	394	395	396	397		398	1	-	401									410		412				416	417	418			

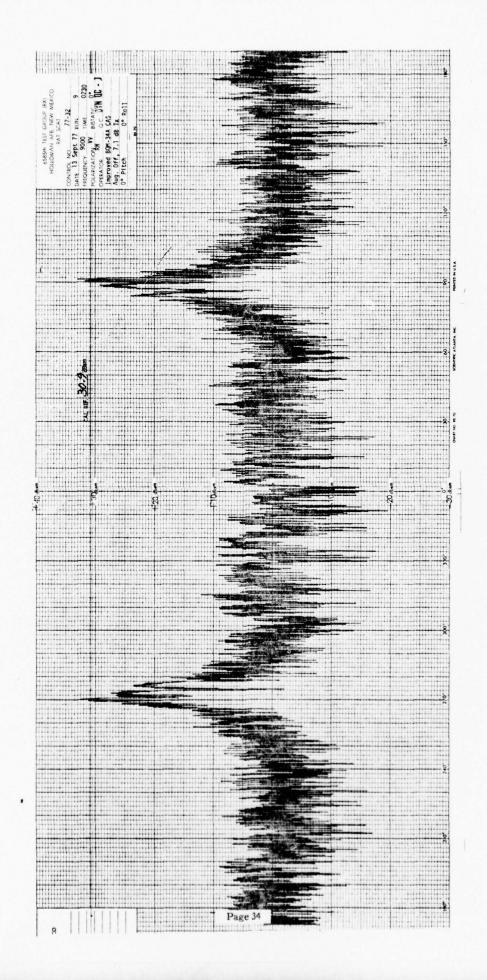
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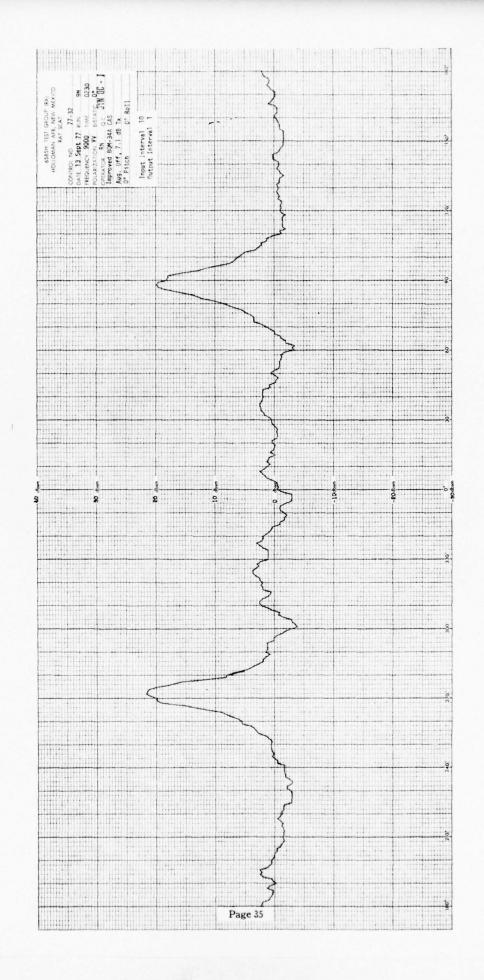
CONT	ROL N	CONTROL NUMBER	77-32		Table I	DATA PLOT INDEX Sheet 14
PAGE NO.	RUN	FREQ (MHz)	POLARI- ZATION	PITCH	ROLL	TARGET CONFIGURATION AND REMARKS
422	6036	10100	Ħ	0	45	Aug. On, Configuration No. 6
423	60366	10100	Ŧ	0	45	Aug. On, Configuration No. 6
424	6035	10100	H	20	0	Aug. Off
425	60356	10100	₹	20	0	Aug. Off
426	6034	10100	٨	20	0	Aug. Off
427	60346	10100	٨	20	0	Aug. Off
428	6030	10100	۸۸	20	0	Aug. On, Configuration No. 5
429	60306	10100	۸۸	20	0	On, Configuration No.
430	6031	10100	圭	20	0	On, Configuration No.
431	60316	10100	₹	20	0	On, Configuration No.
432	6032	10100	壬	20	0	On, Configuration No.
433	60326	10100	壬	20	0	Aug. On, Configuration No. 6
434	6033	10100	۸۸	20	0	On, Configuration No.
435	60336	10100	٨	20	0	
436	6014	10100	٨	-20	0	
437	60146	10100	W	-20	0	Aug. Off
438	6013	10100	H	-20	0	
439	60136	10100	壬	-20	0	Aug. Off
440	6020	10100	Ŧ	-20	0	Aug. On, Configuration No. 5
441	60206	10100	Ŧ	-20	0	
442	6019	10100	۸	-20	0	On, Configuration No.
443	96109	10100	۸۸	-20	0	On, Configuration No.
444	6011	10100	۸۸	-20	0	. On, Configuration No.
445	60116	10100	۸۸	-20	0	On, Configuration No.
446	6012	10100	HH	-20	. 0	On, Configuration No.
447	60126	10100	Ŧ	-20	Û	Aug. On, Configuration No. 6

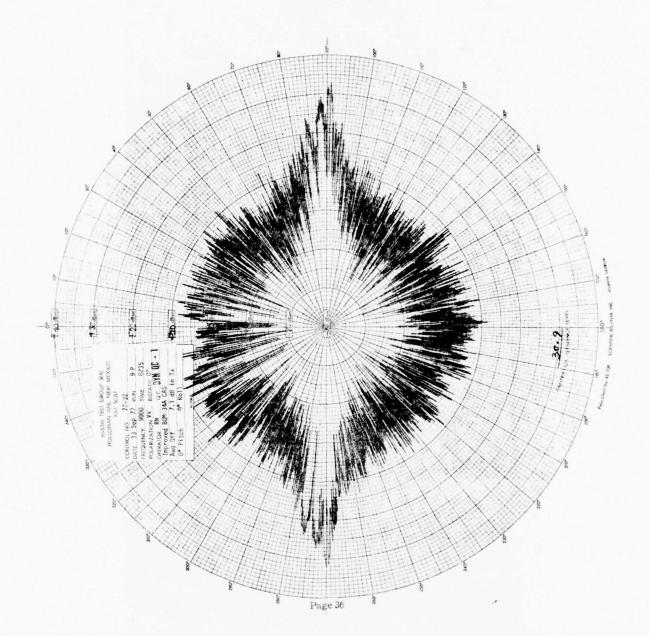
RBD 72 007

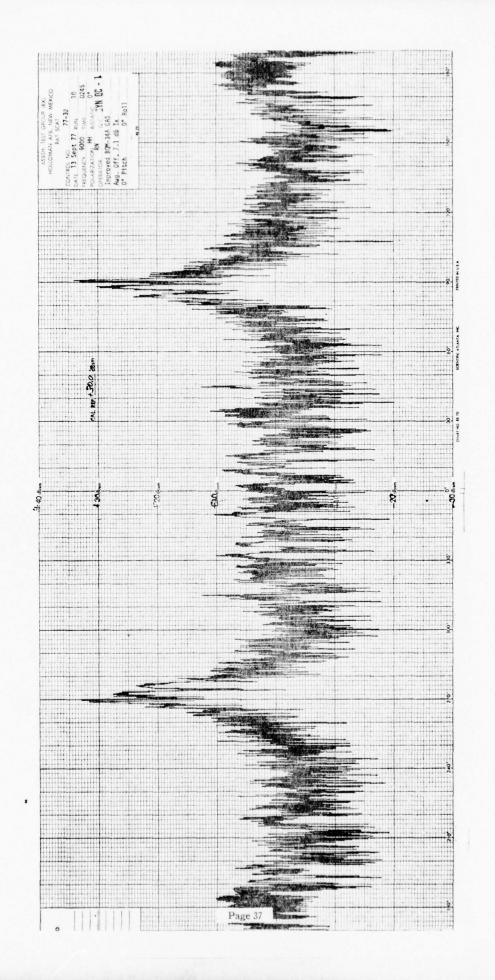


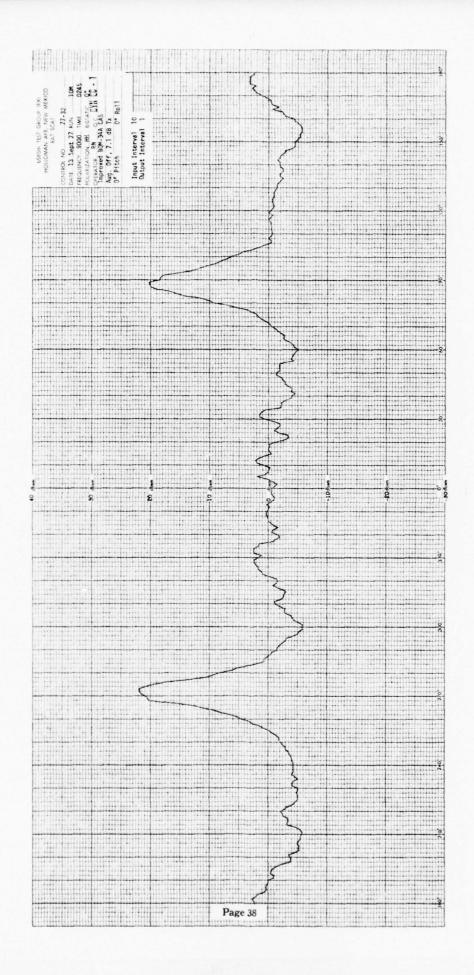


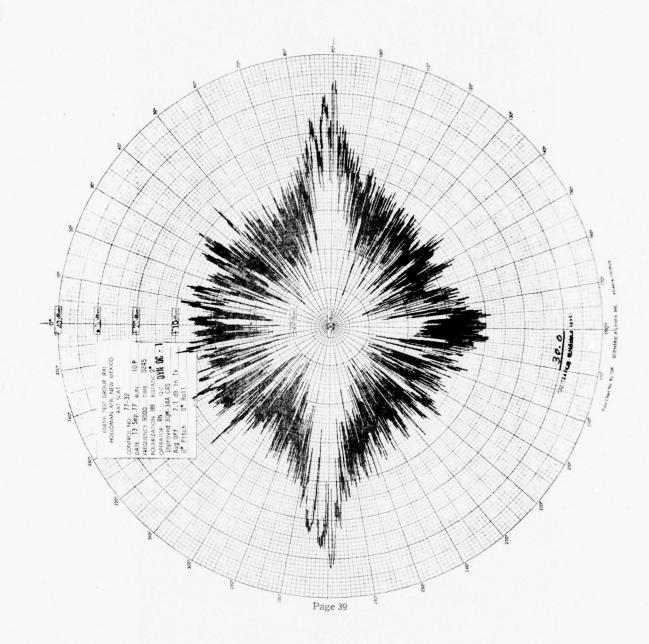


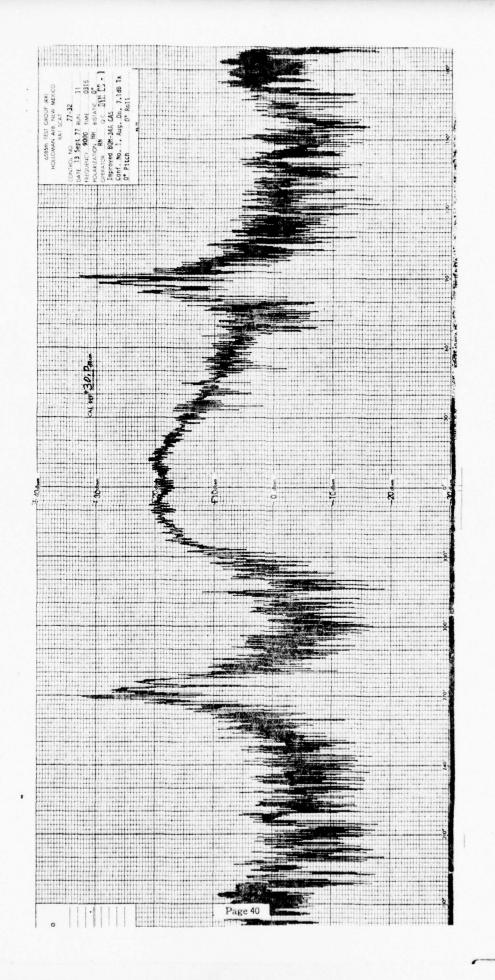


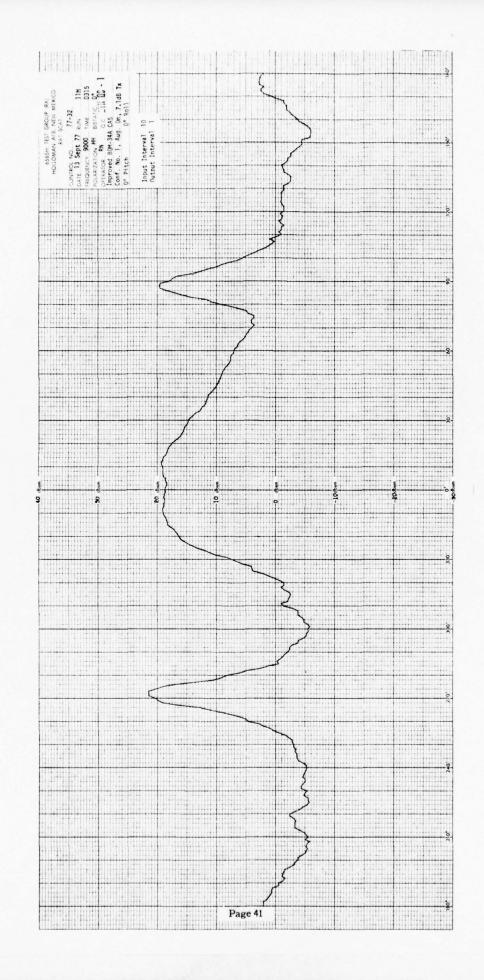


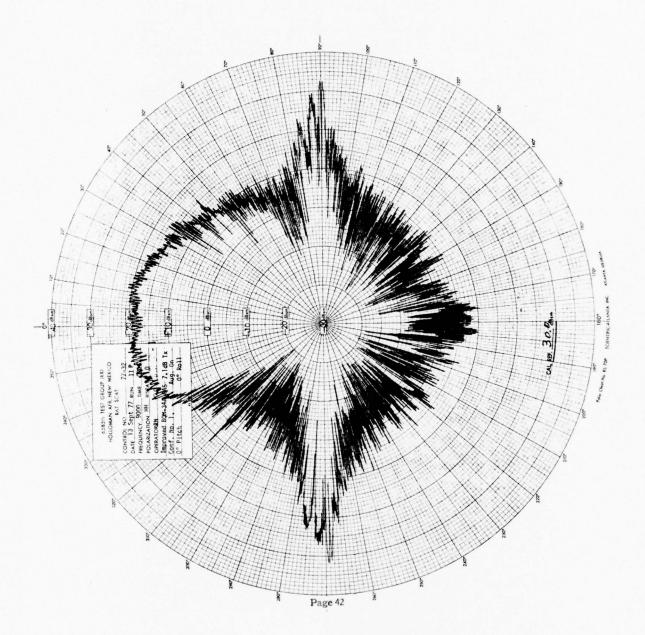


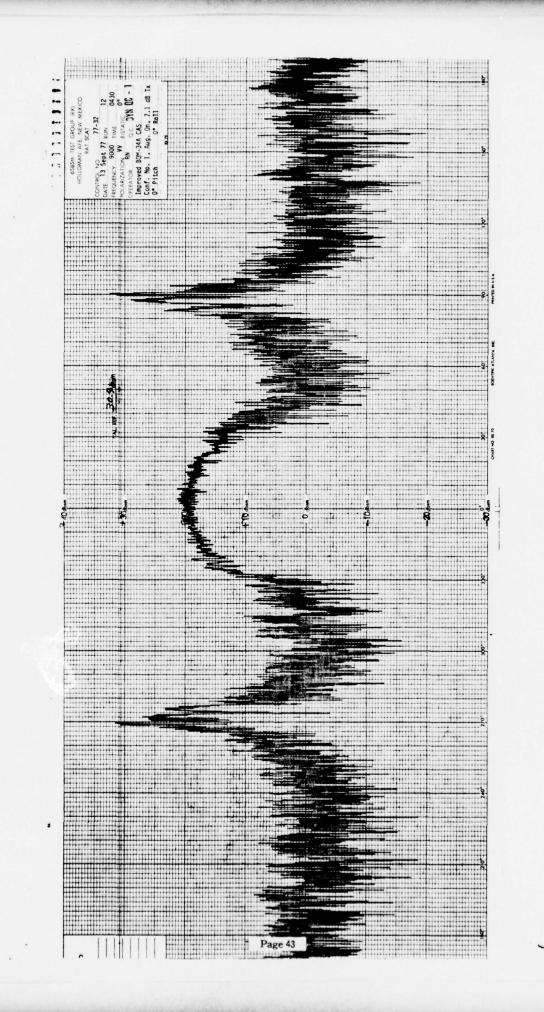


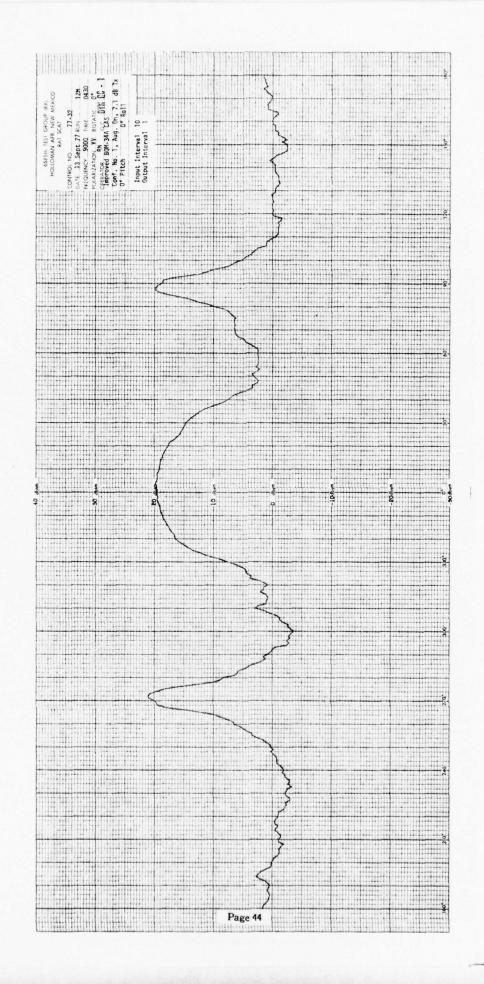


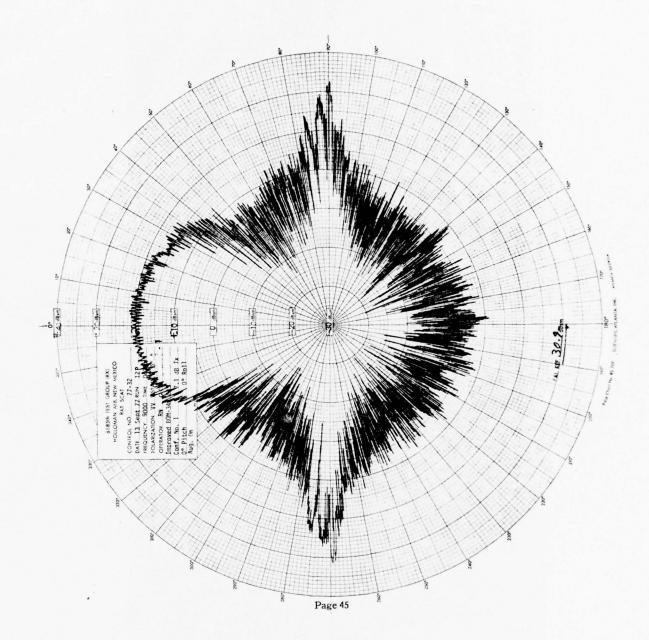


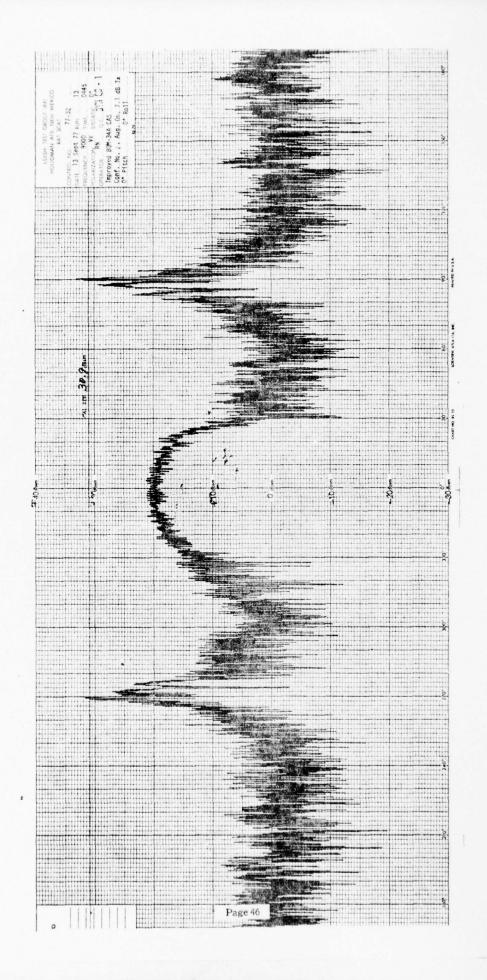


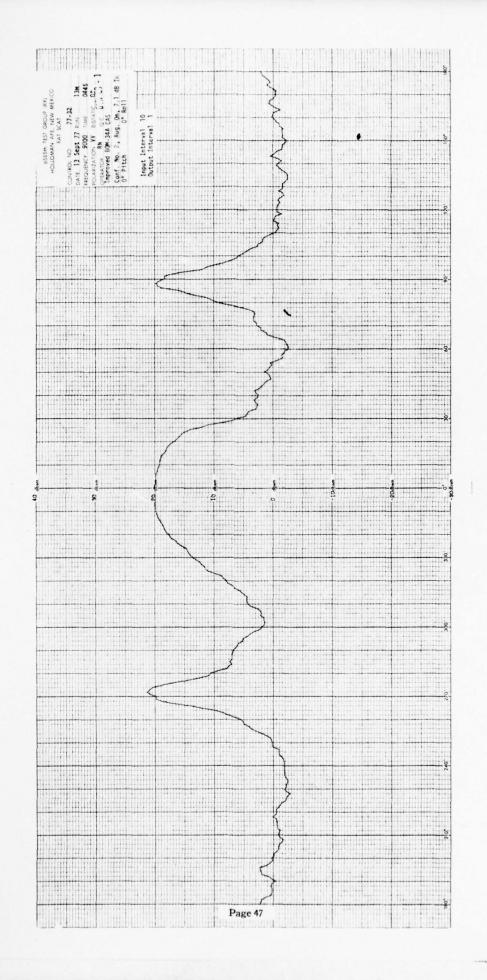


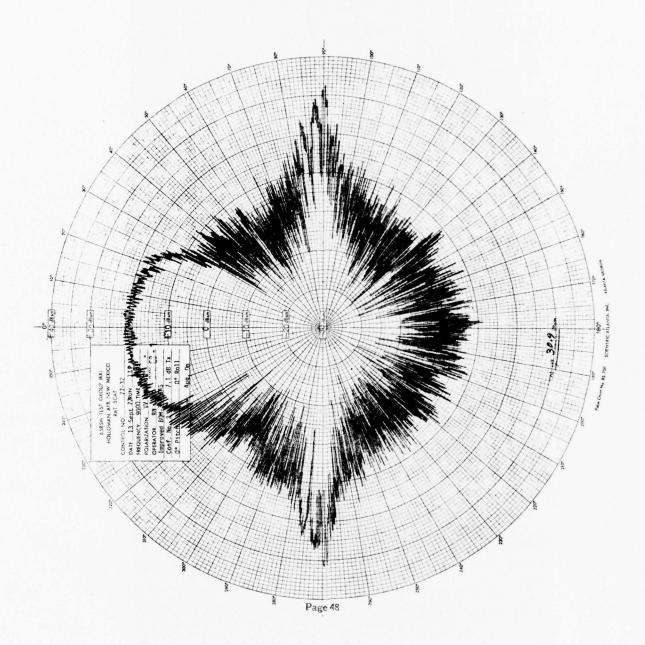


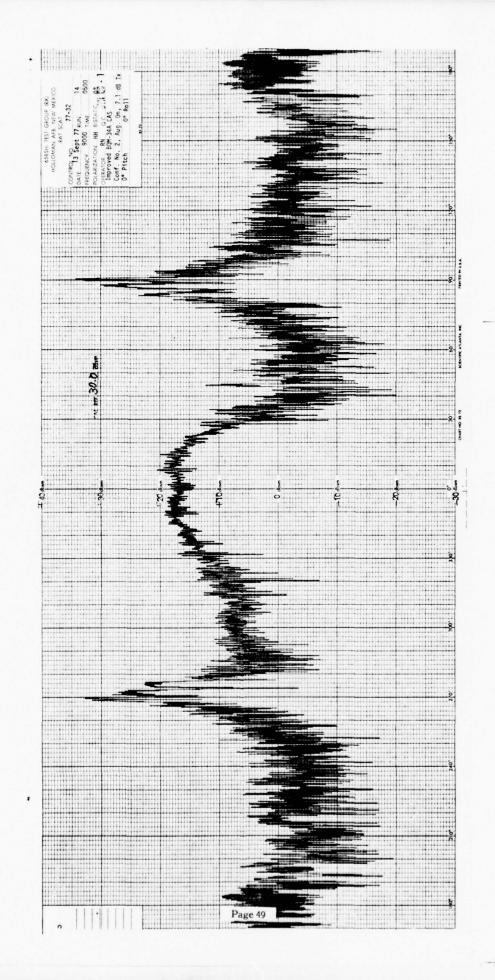


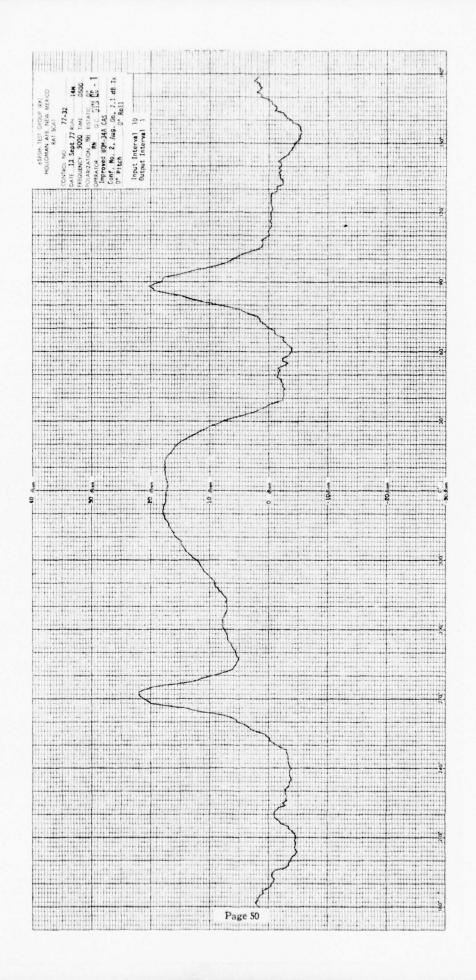


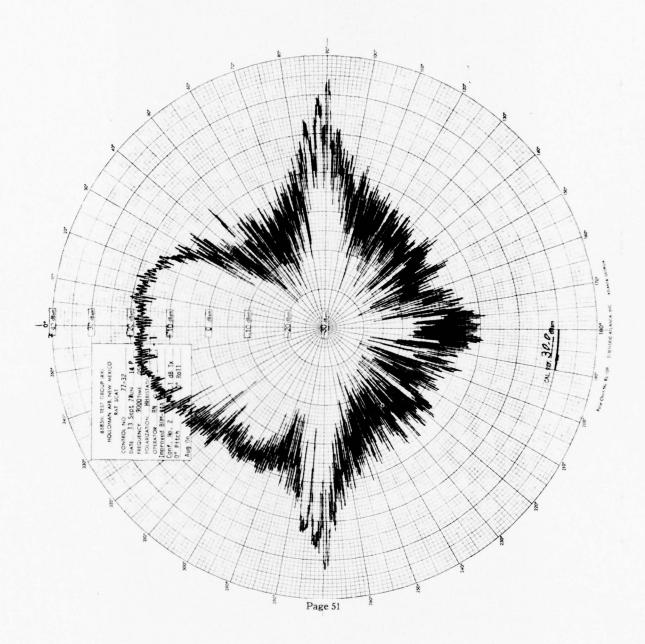


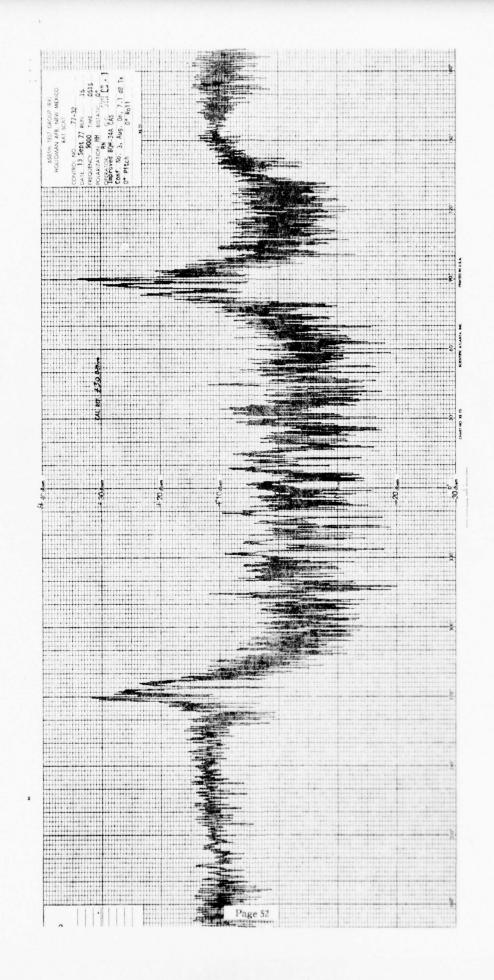


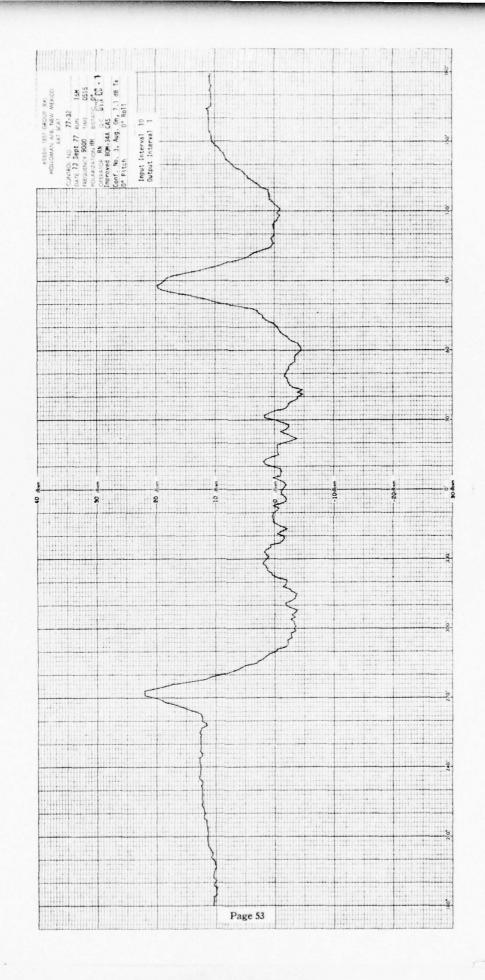


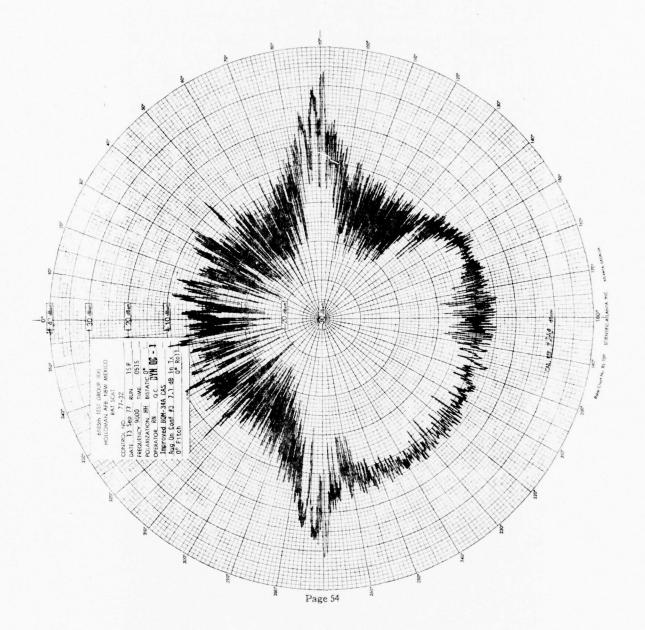


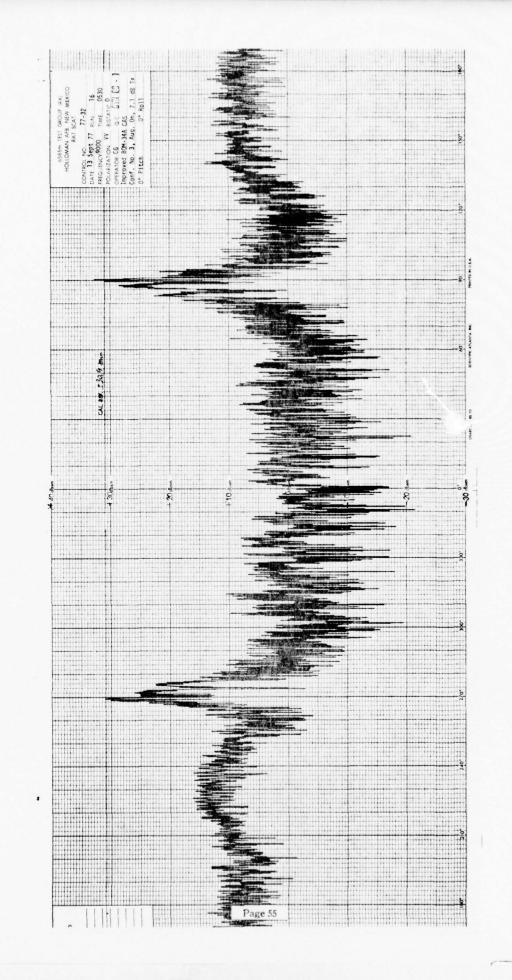


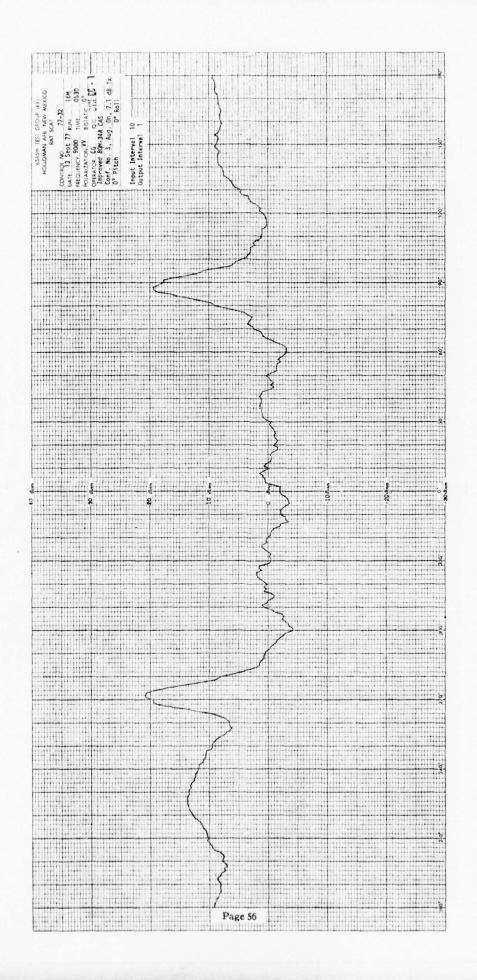


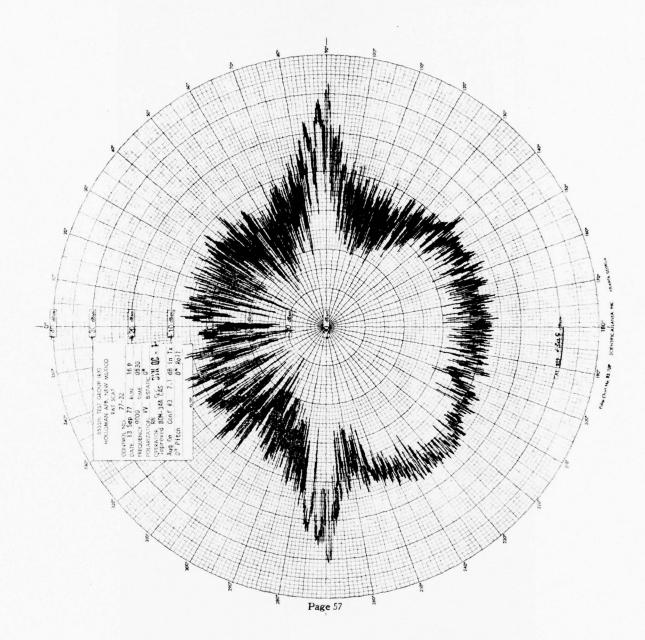


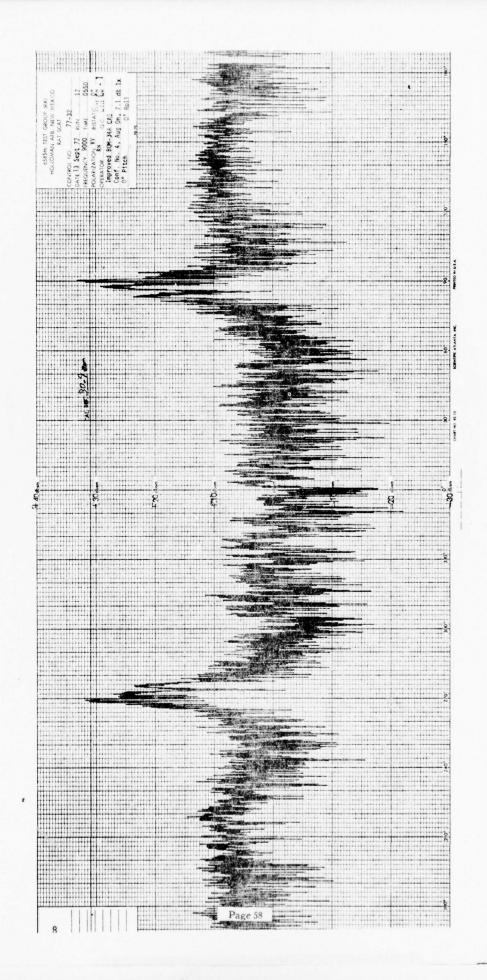


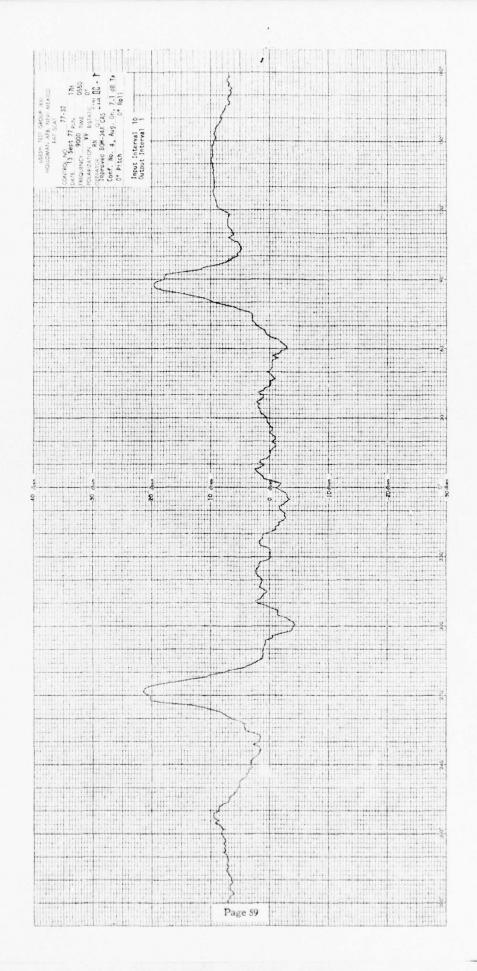


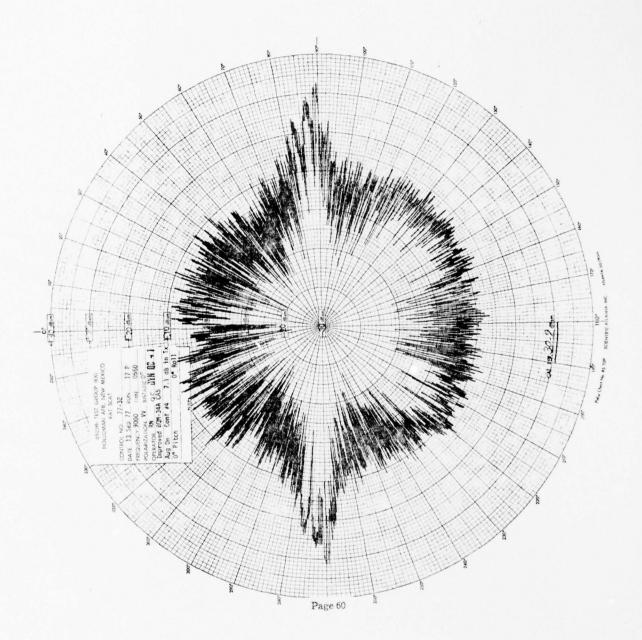


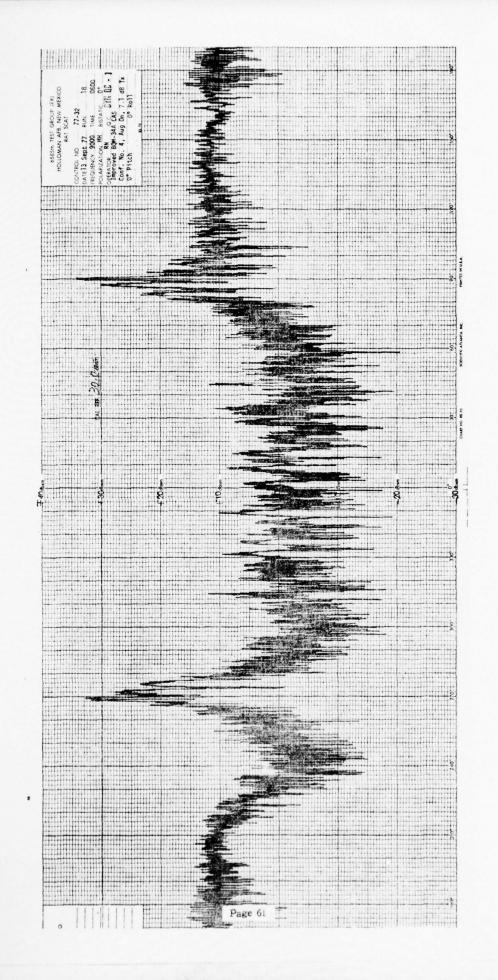


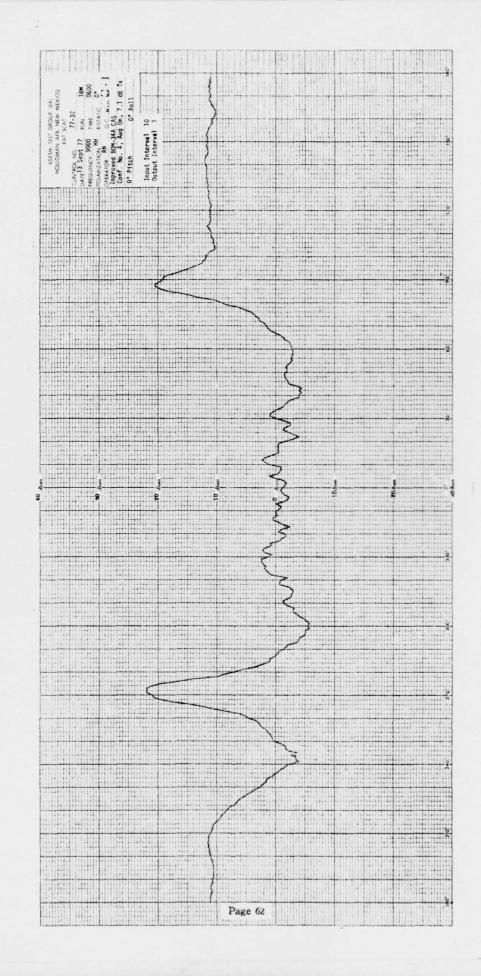


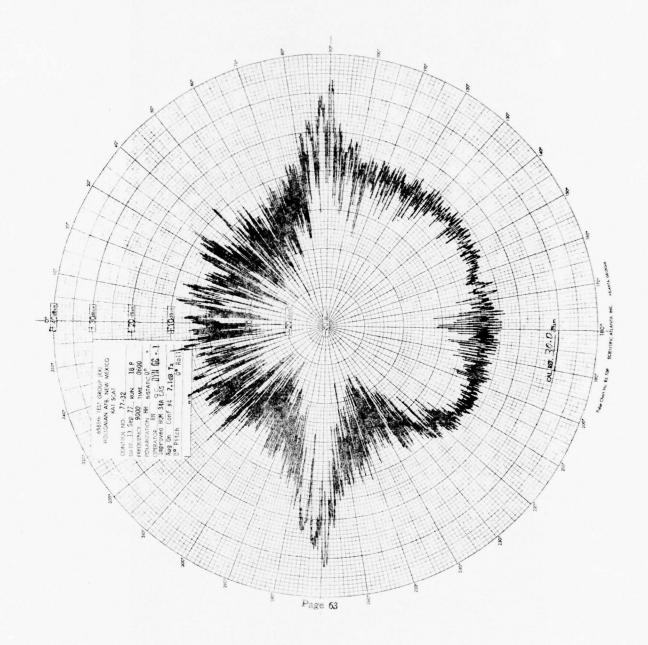


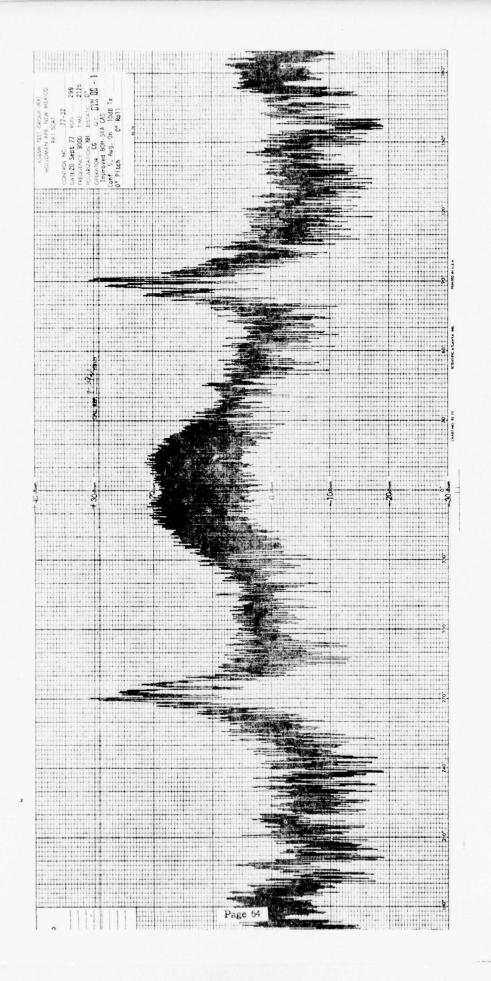


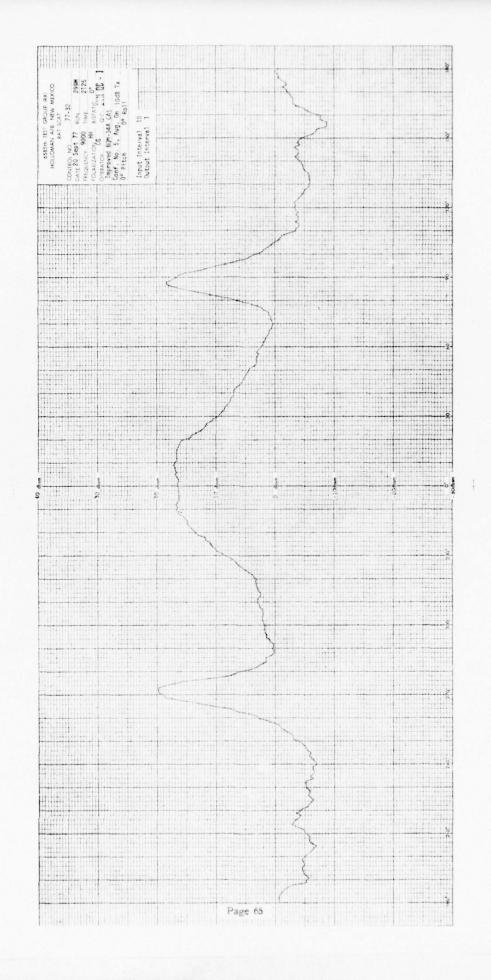


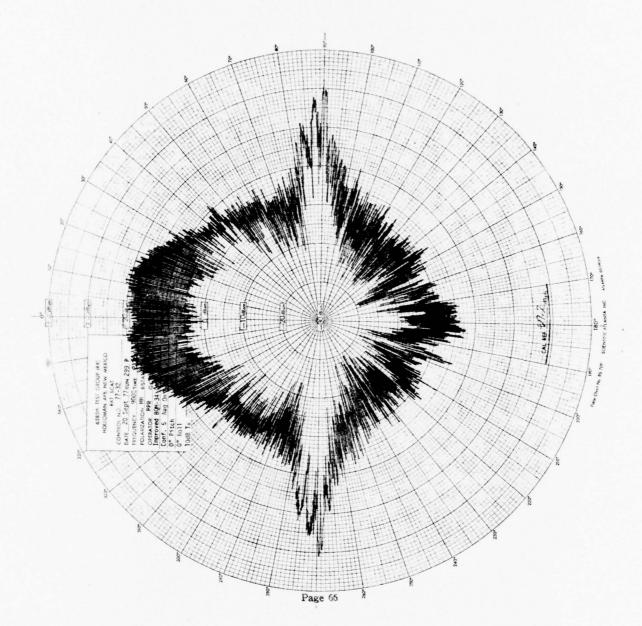


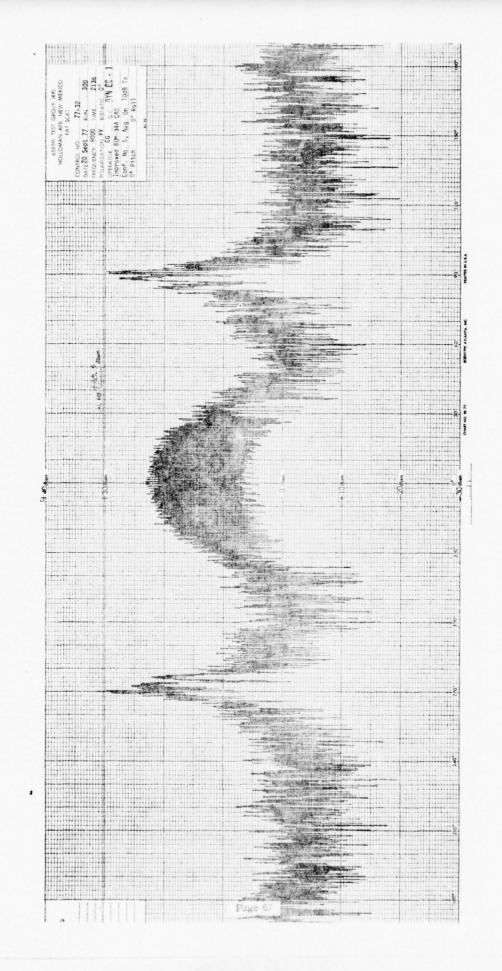


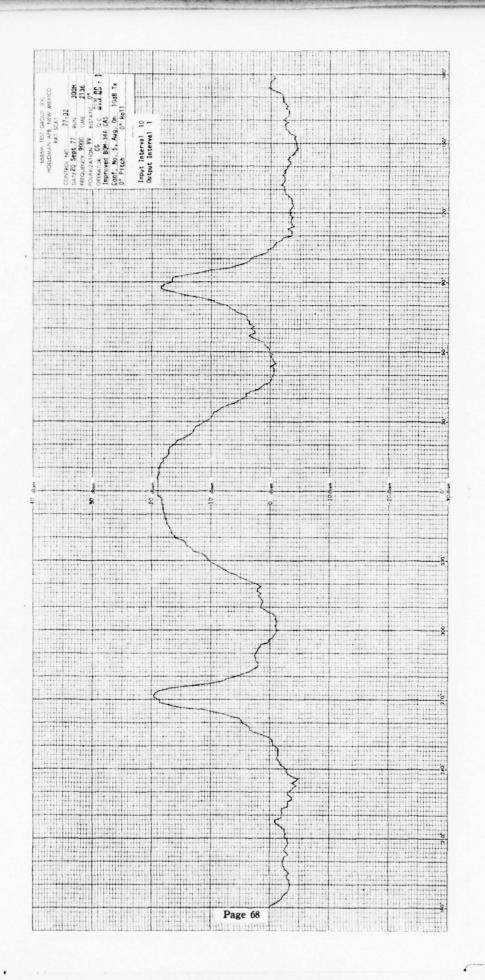


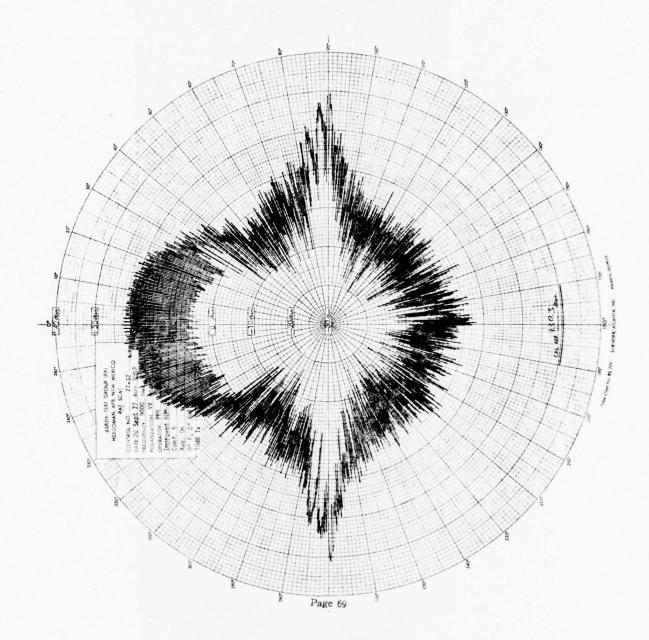


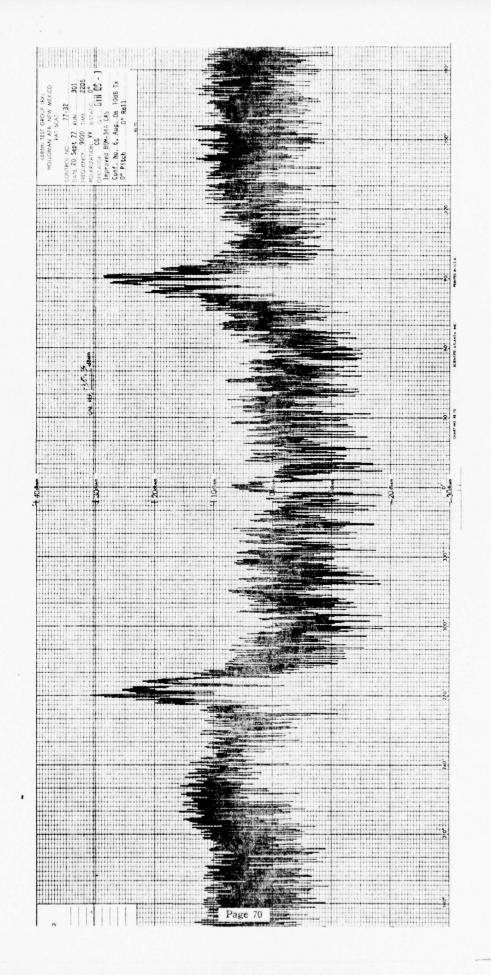


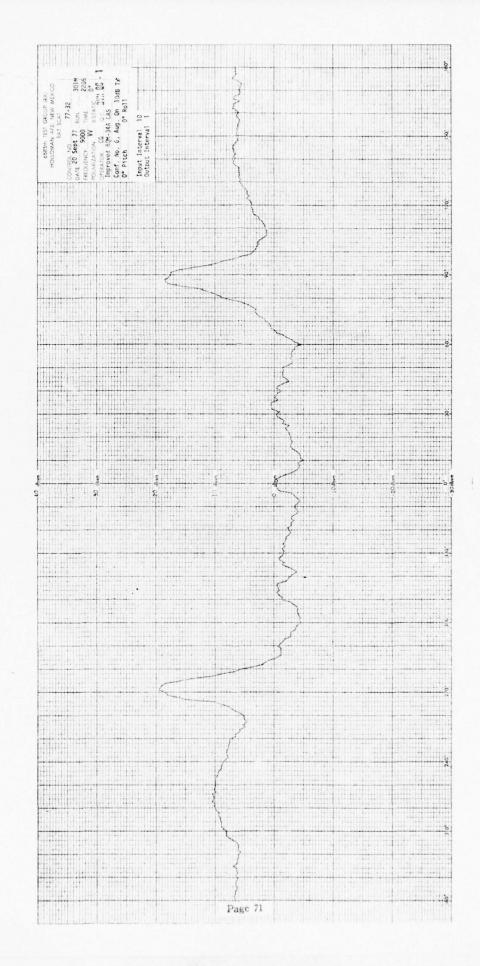


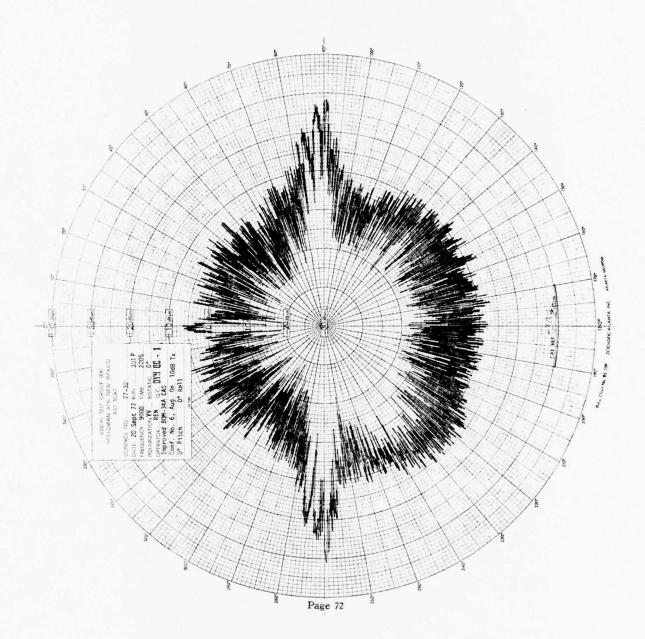


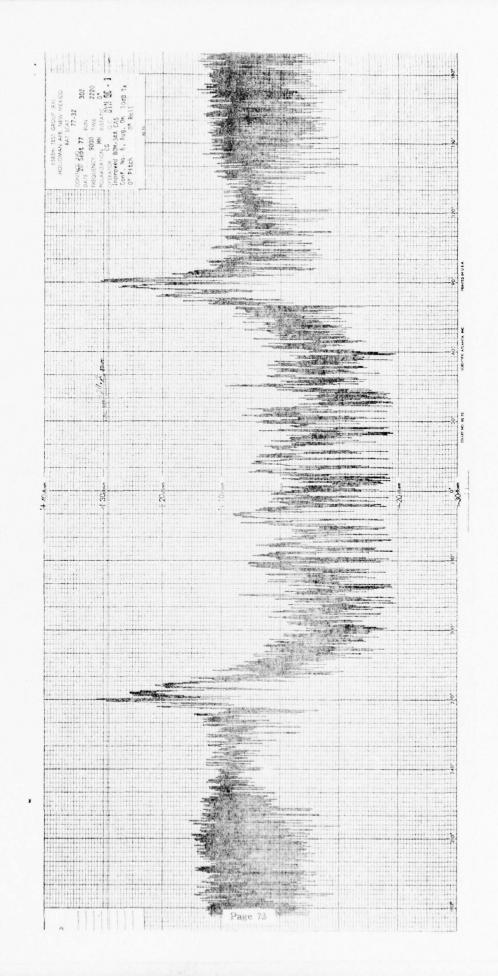


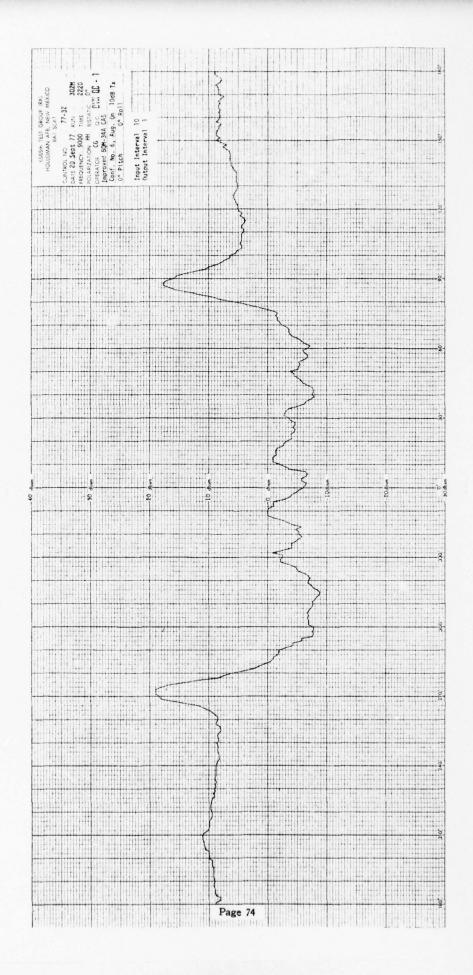


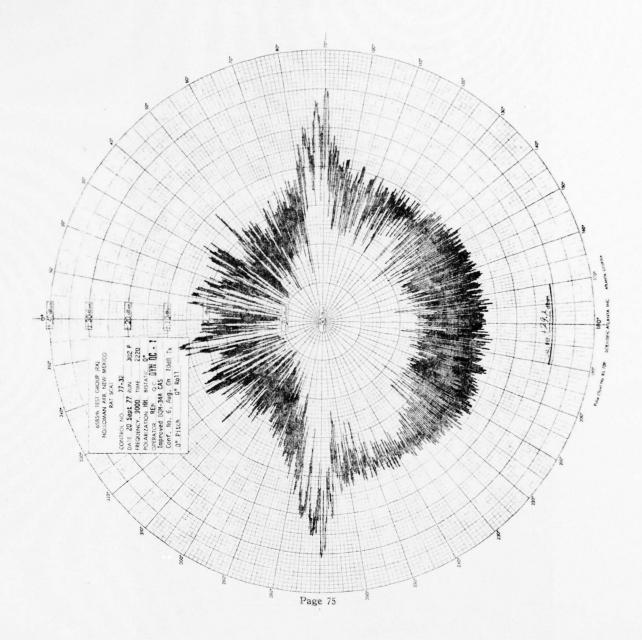


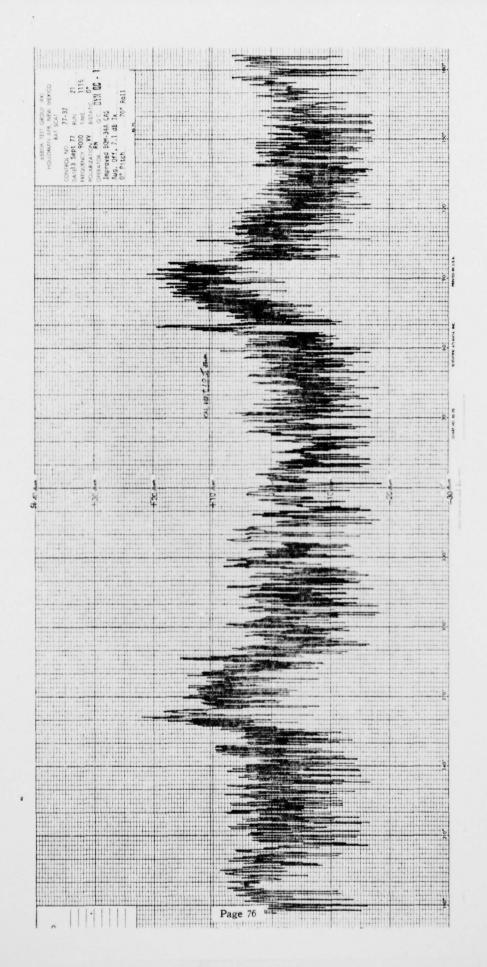


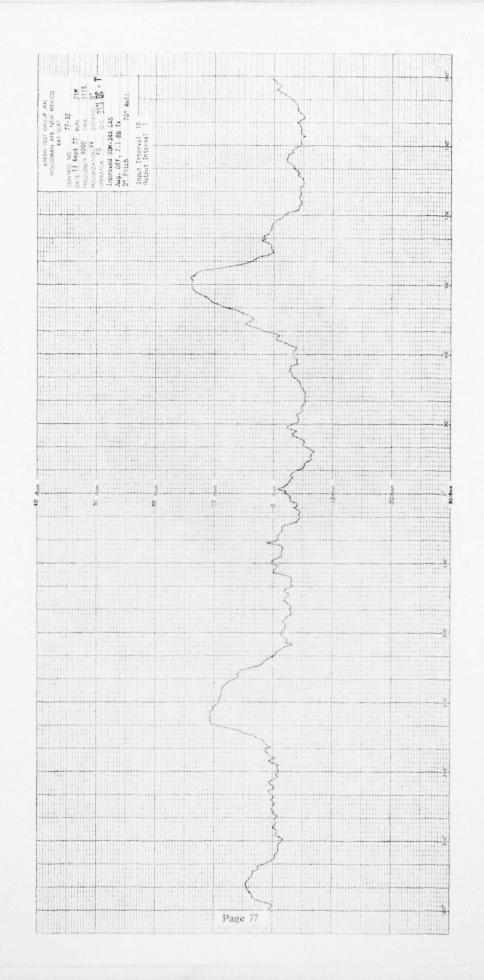


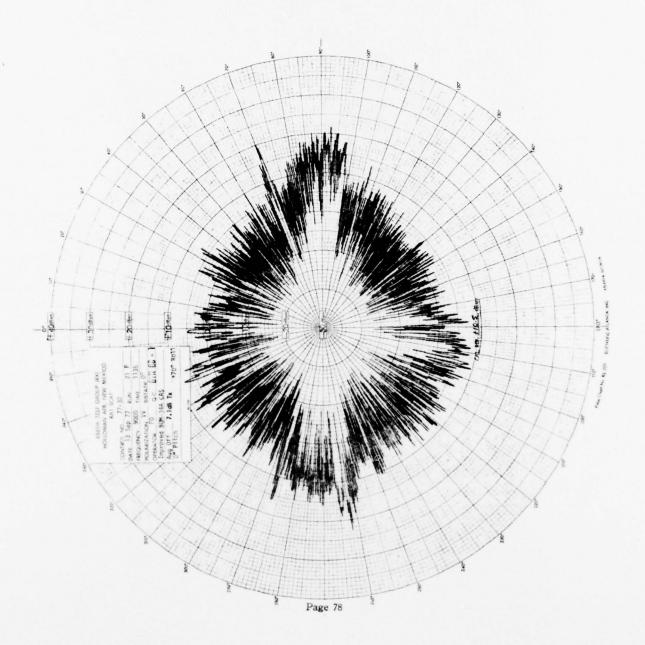


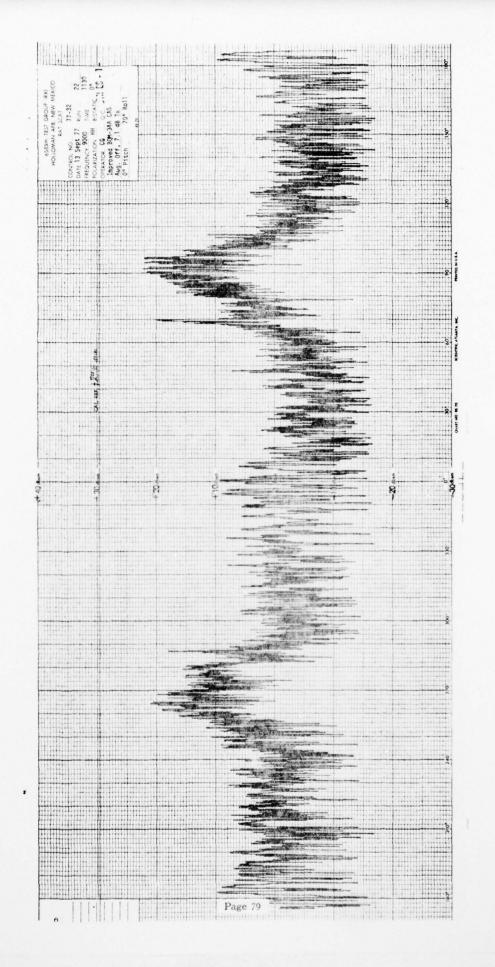


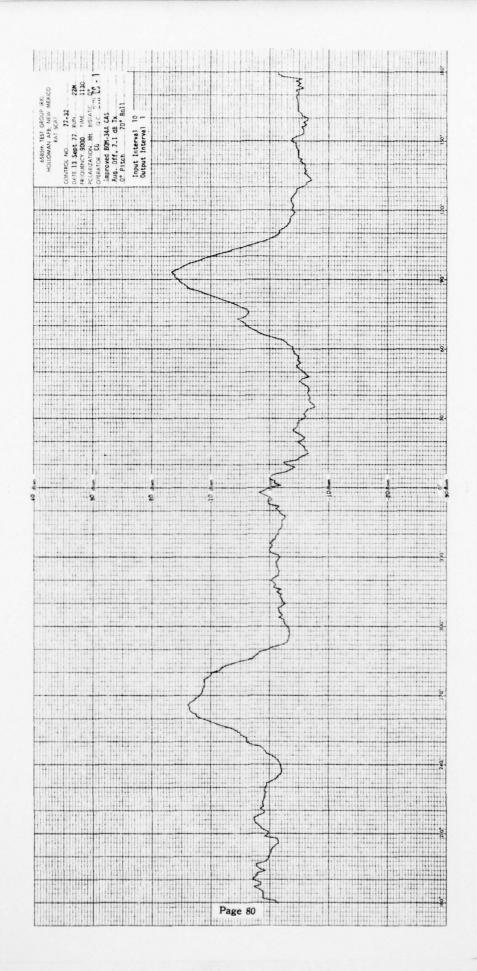


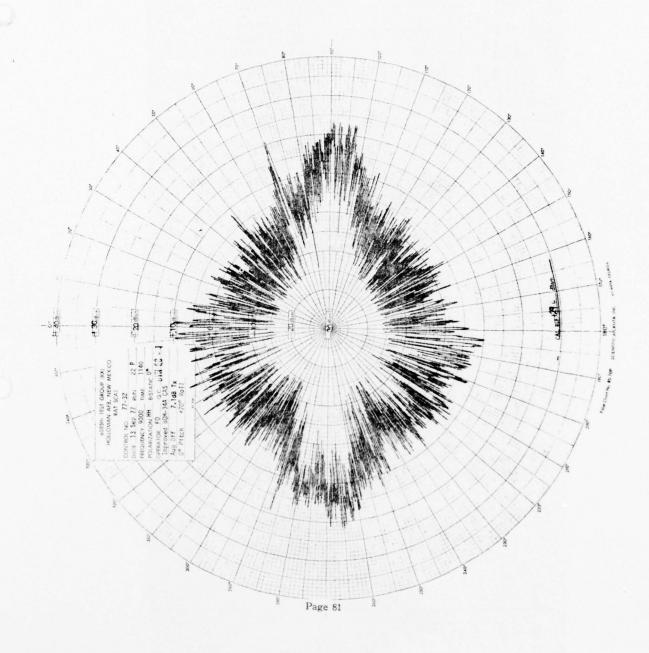


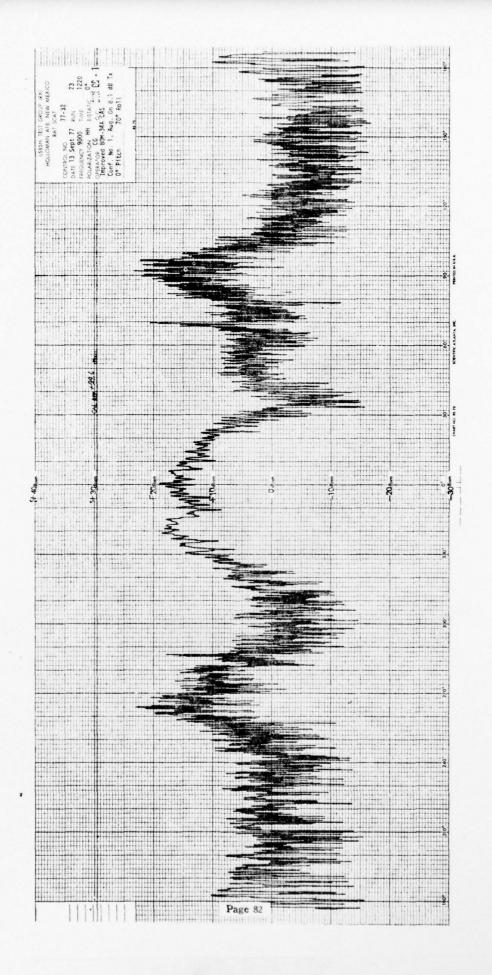


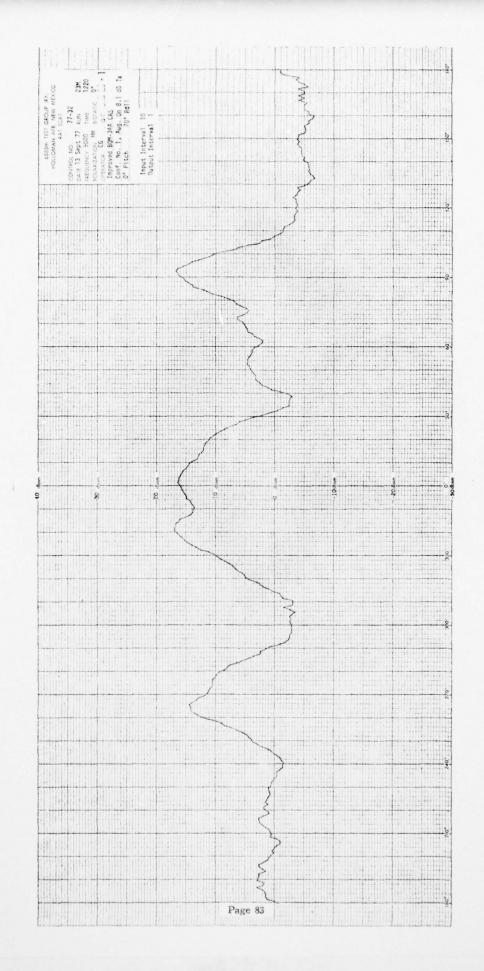


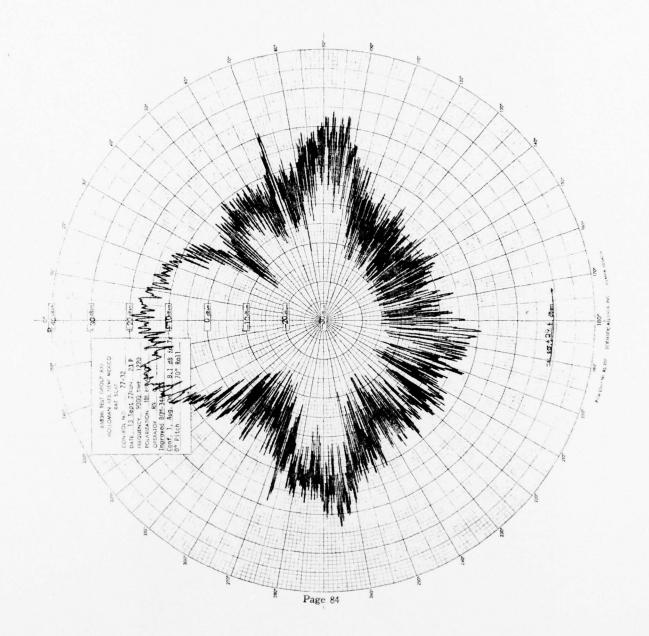


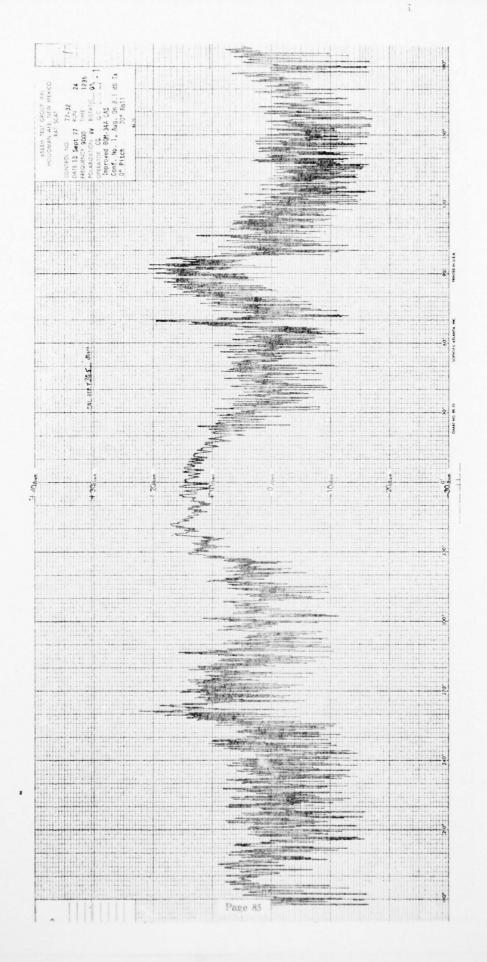


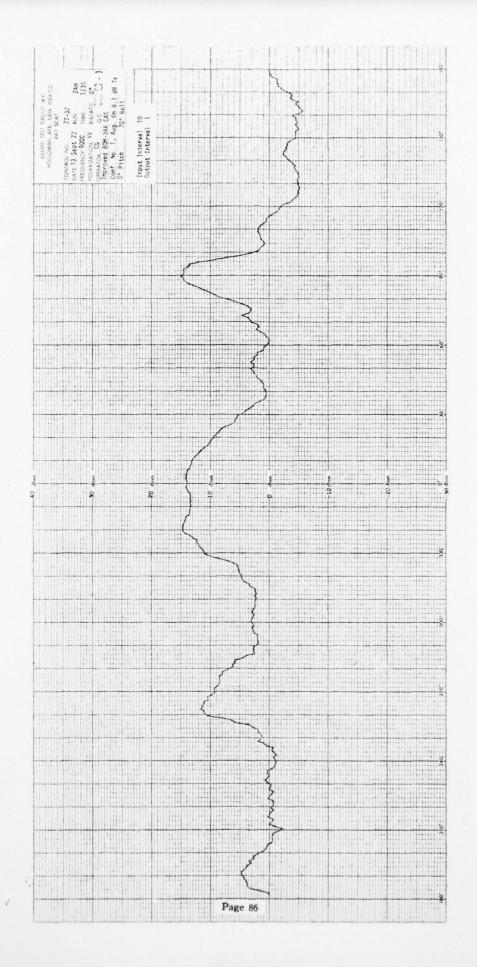


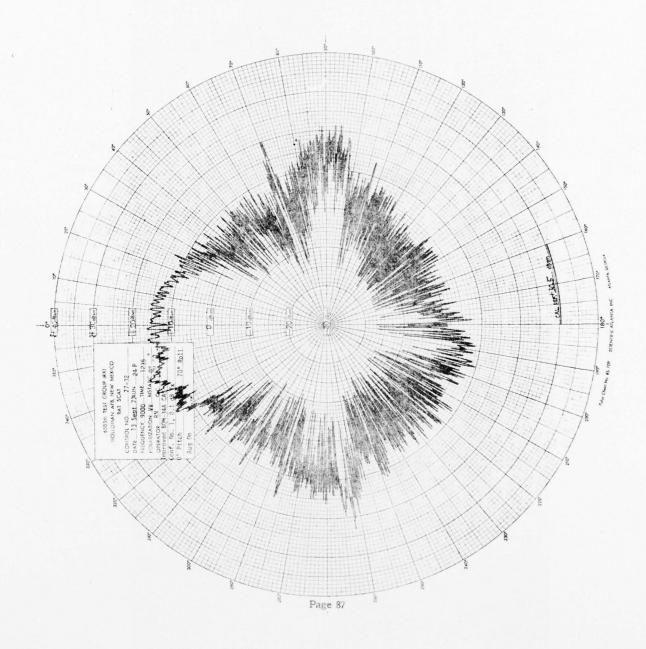


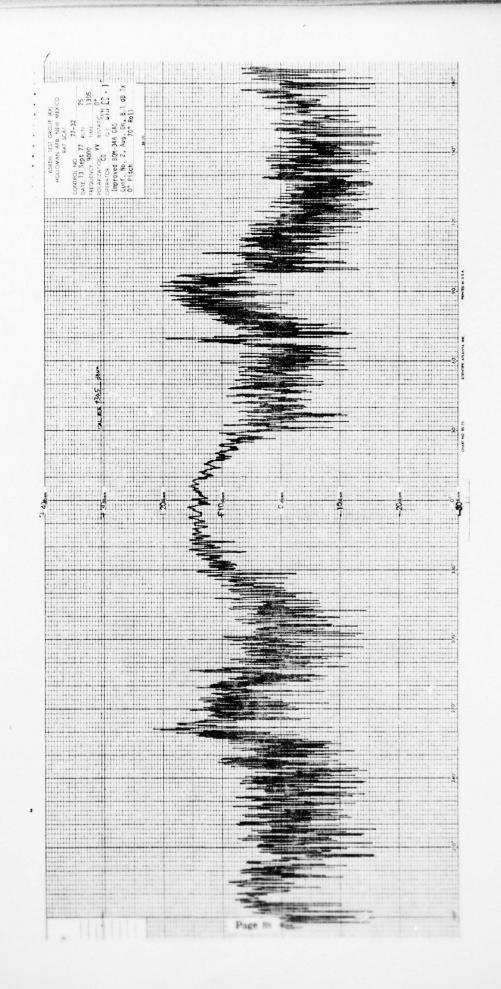


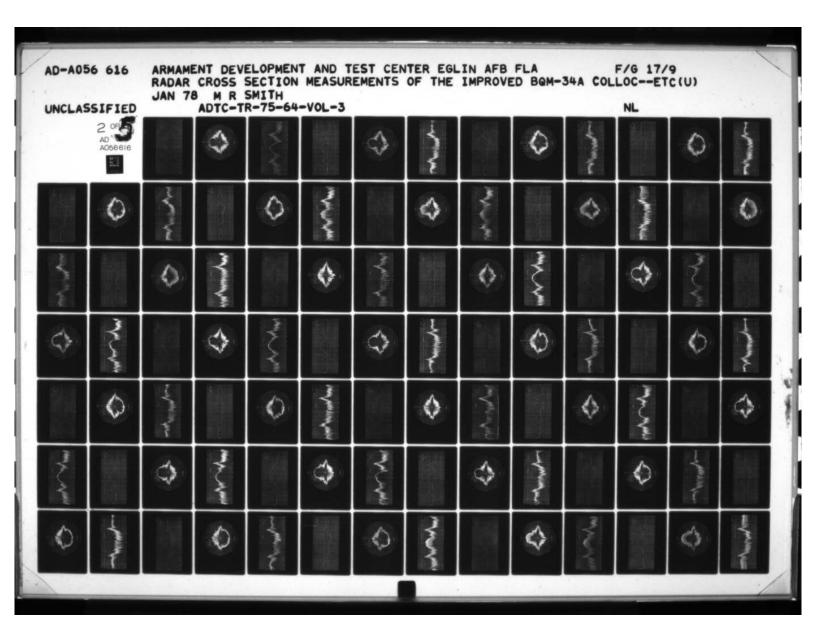




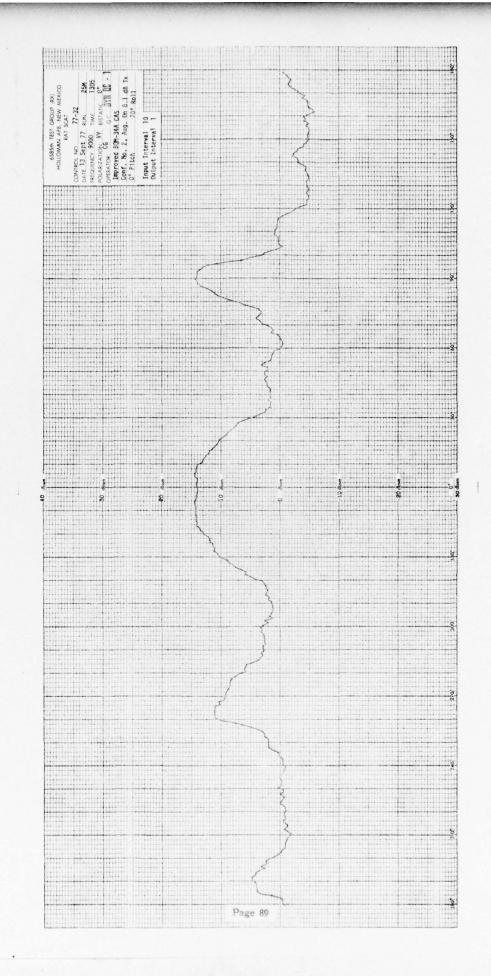


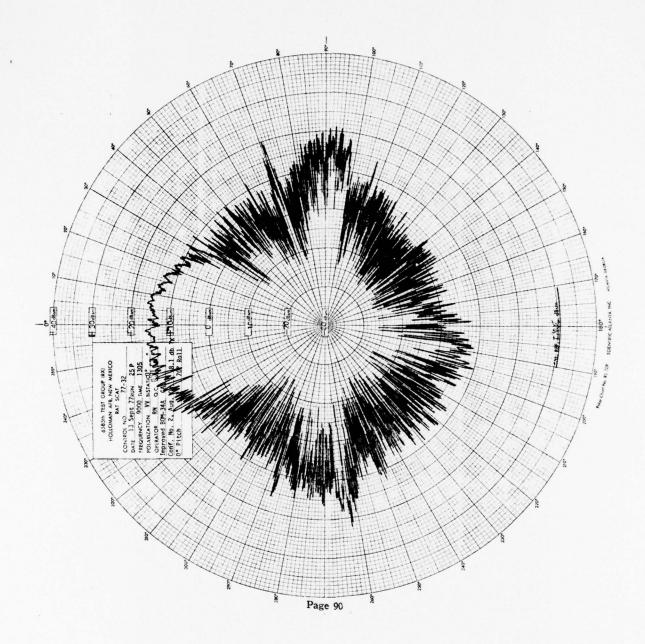


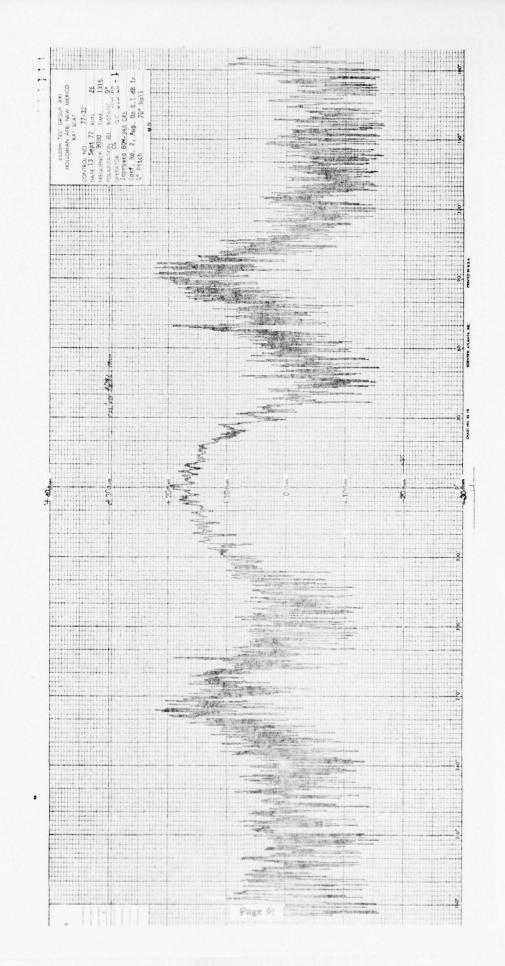


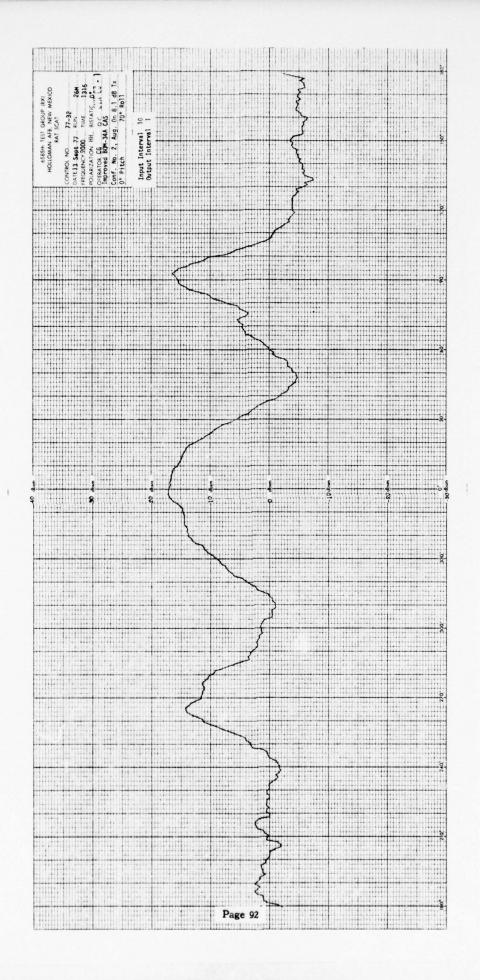


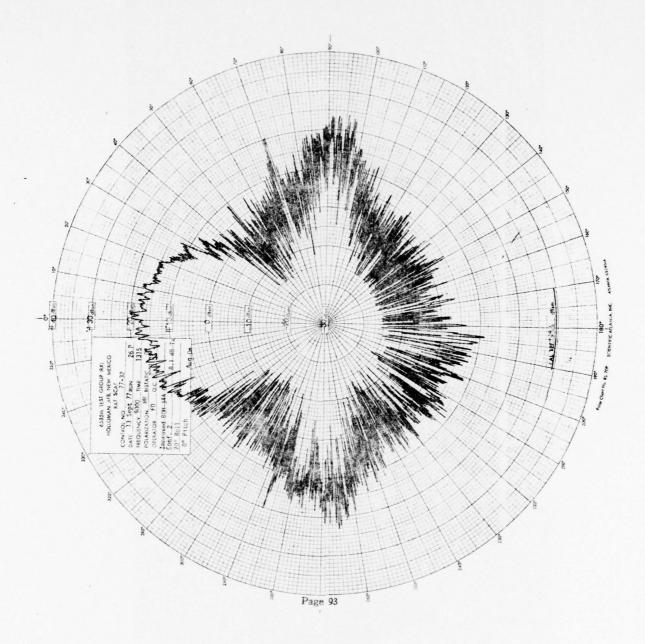


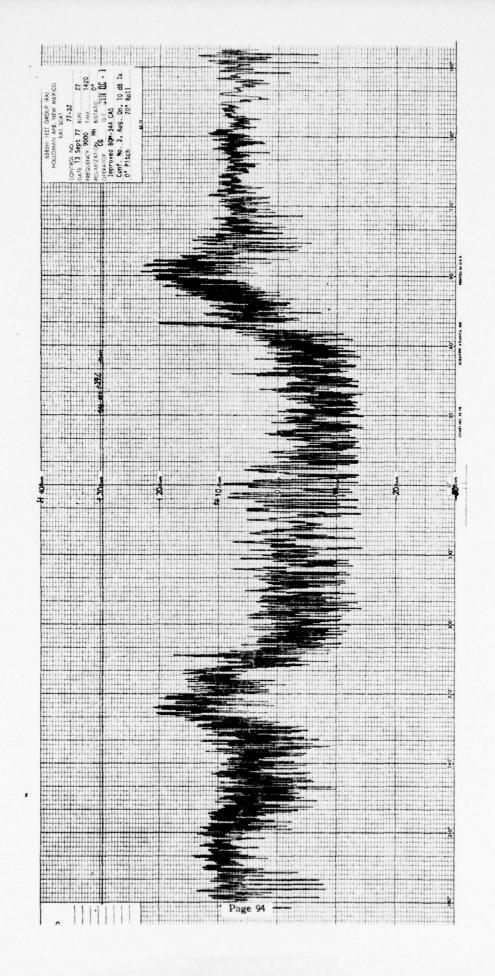


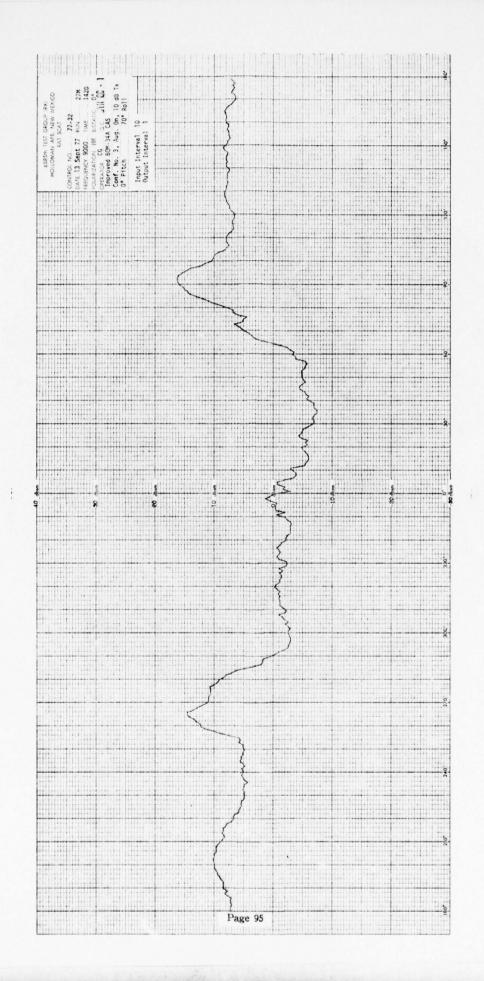


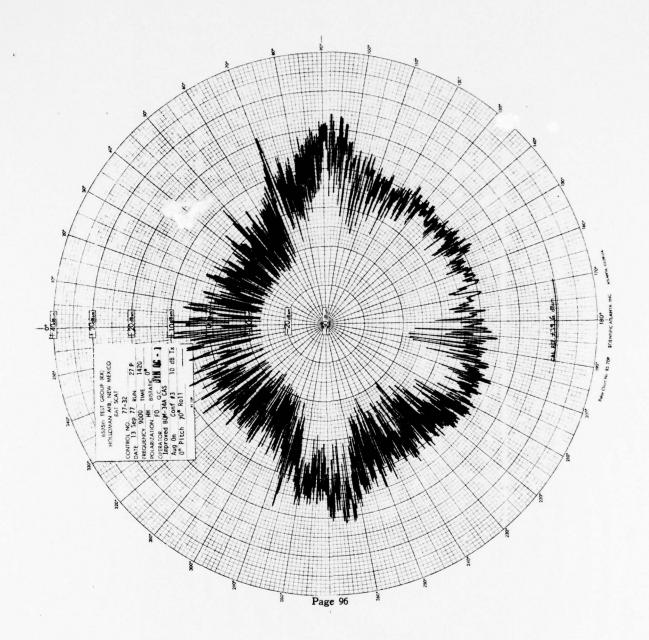


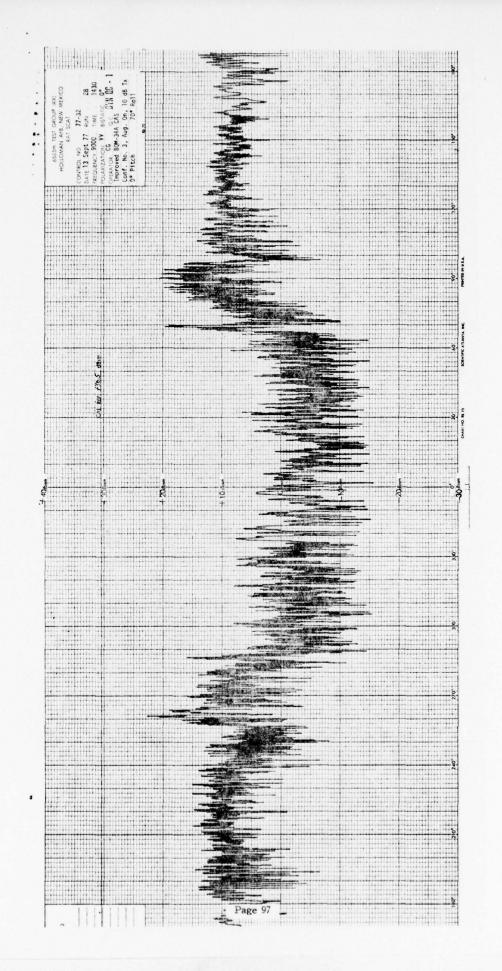


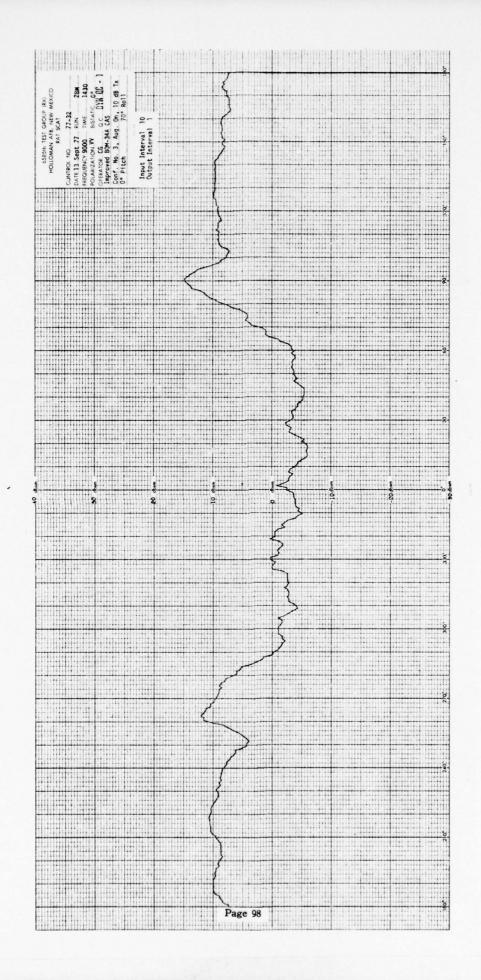


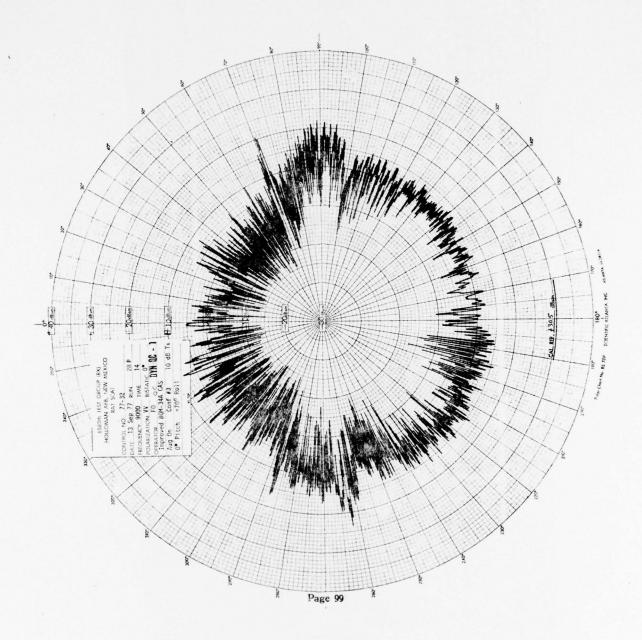


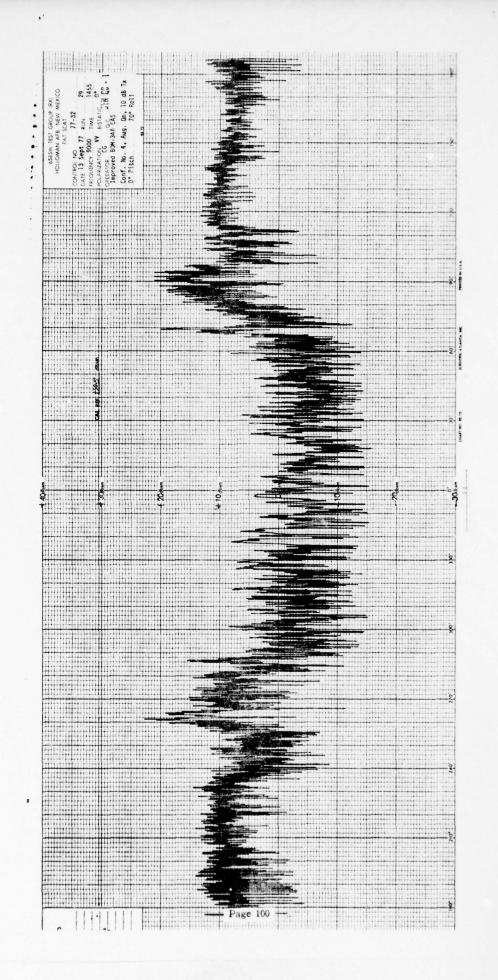


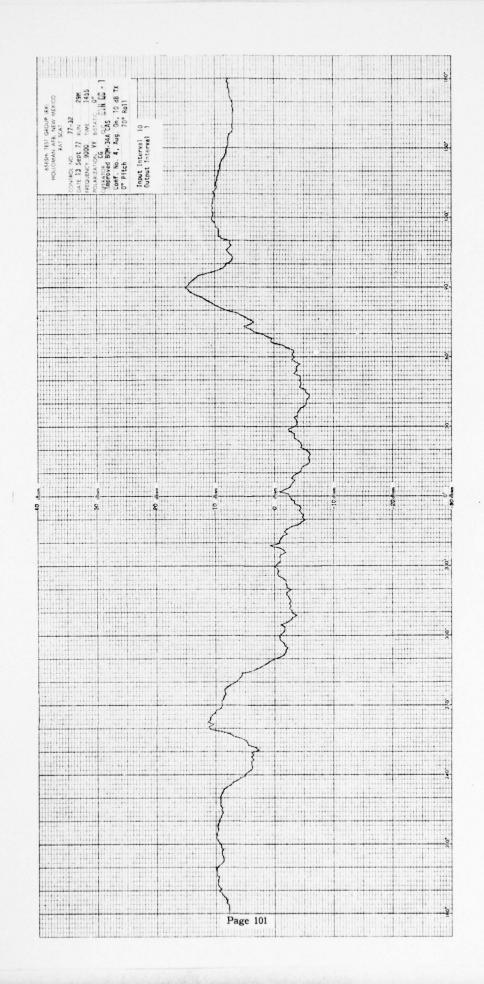


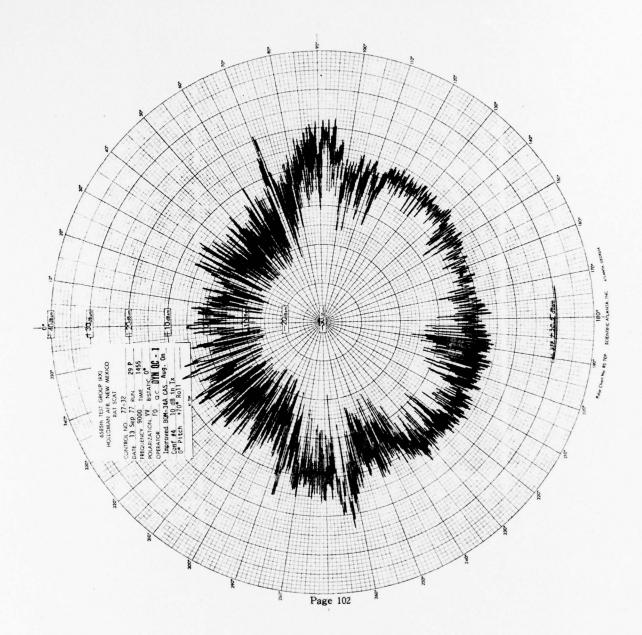


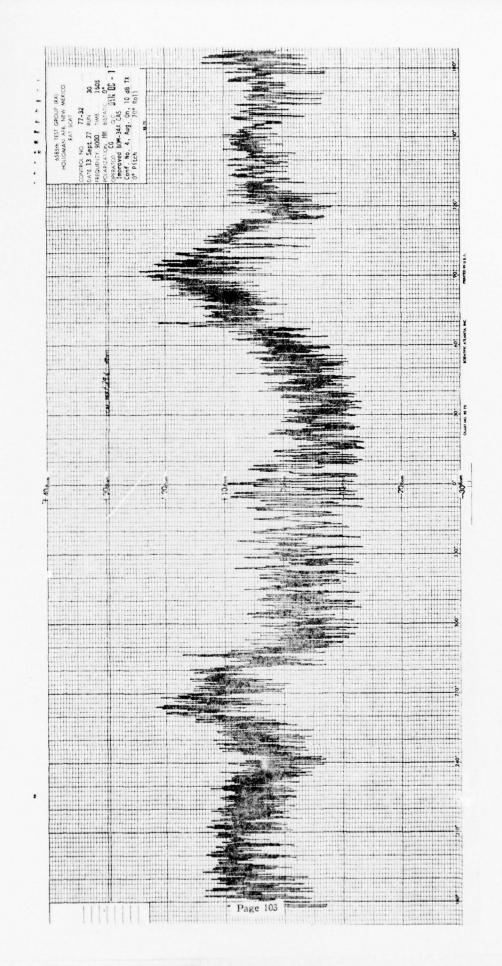


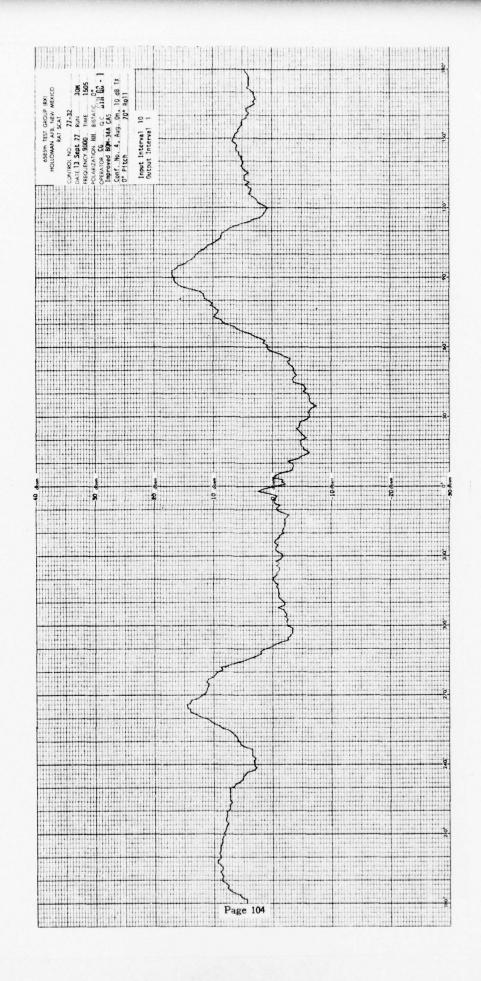


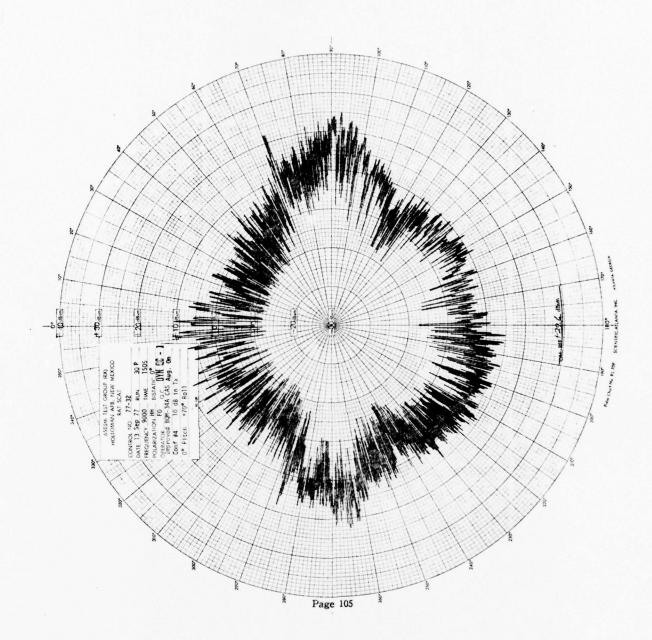


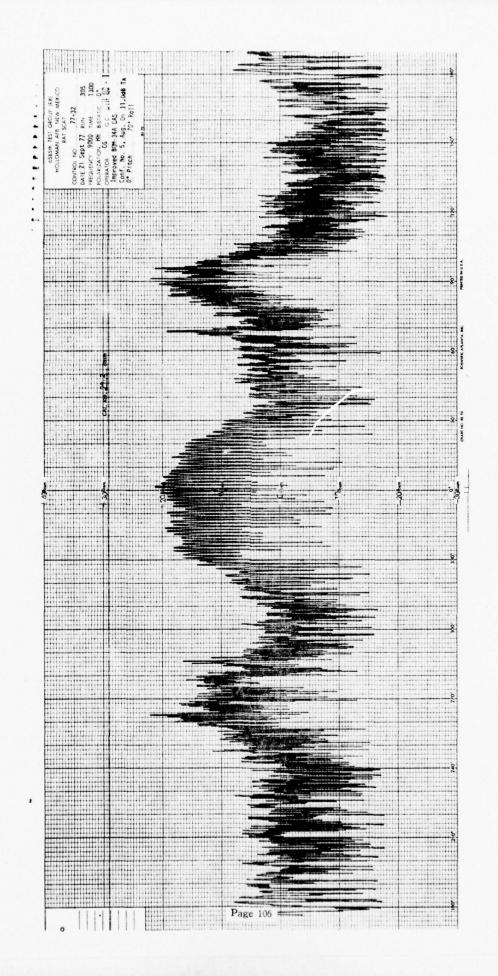


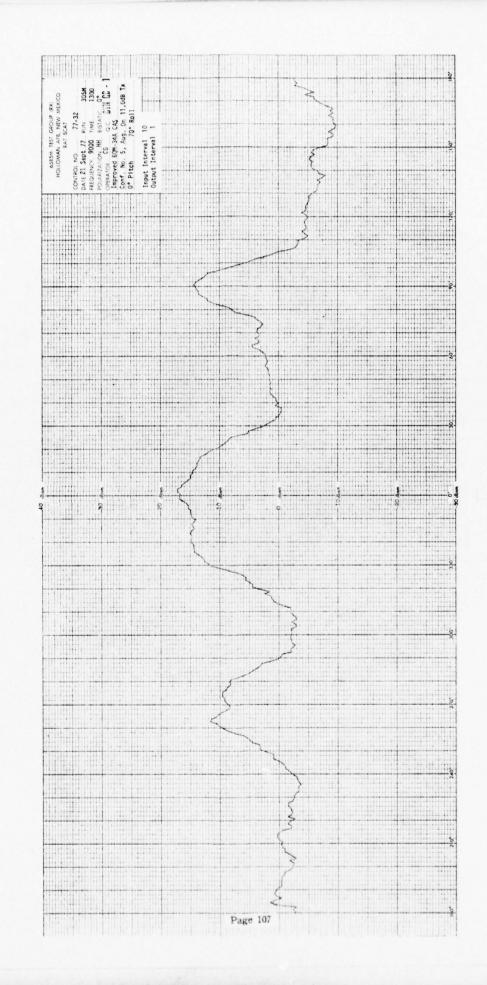


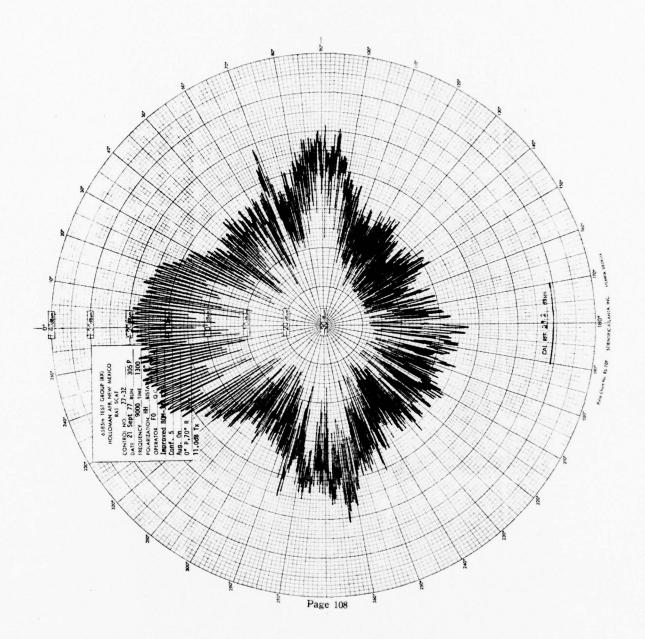


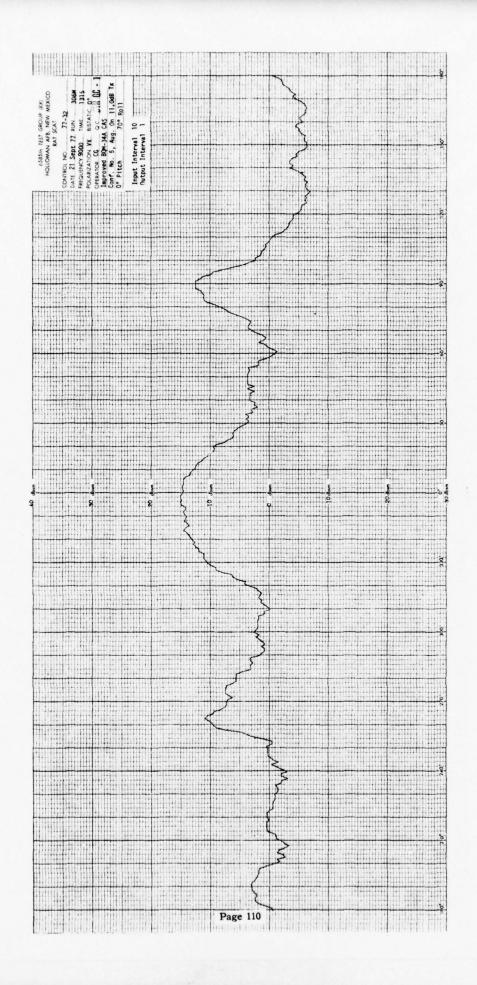


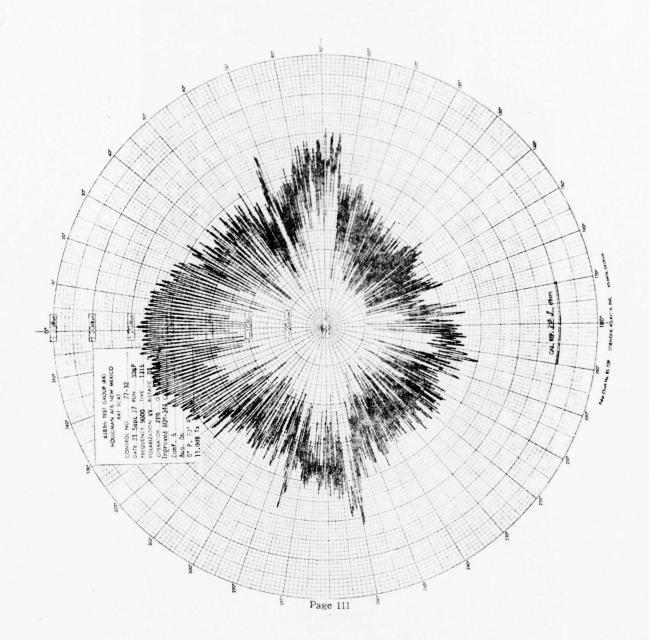


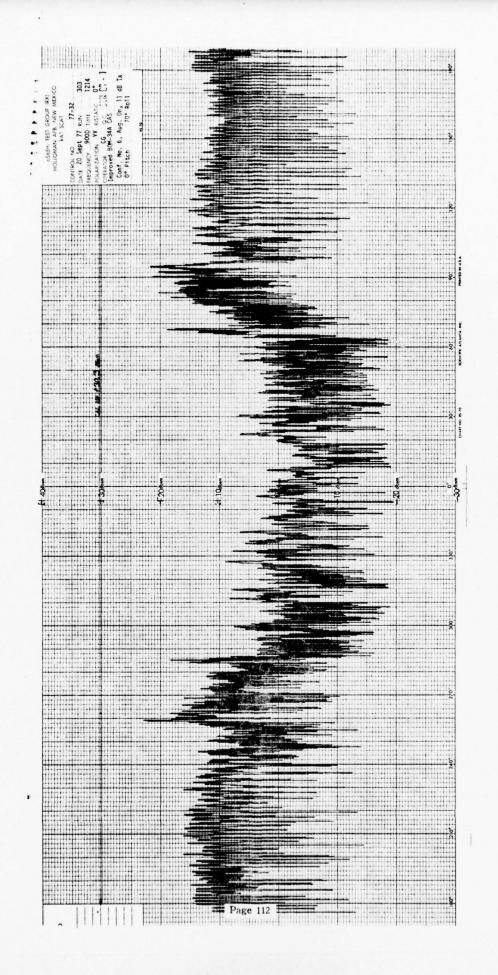


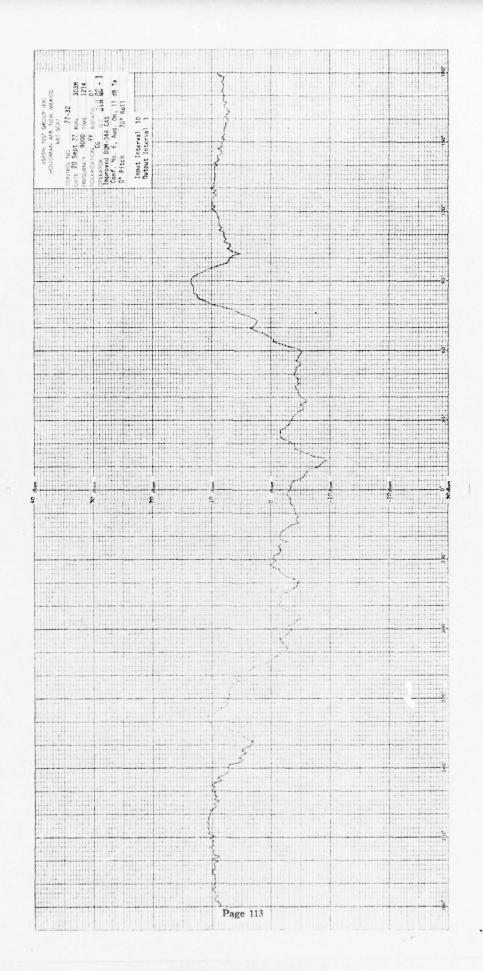






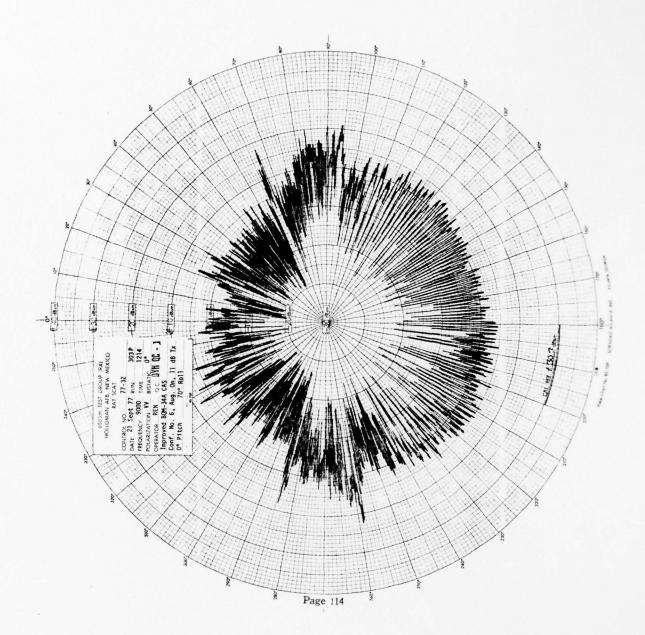


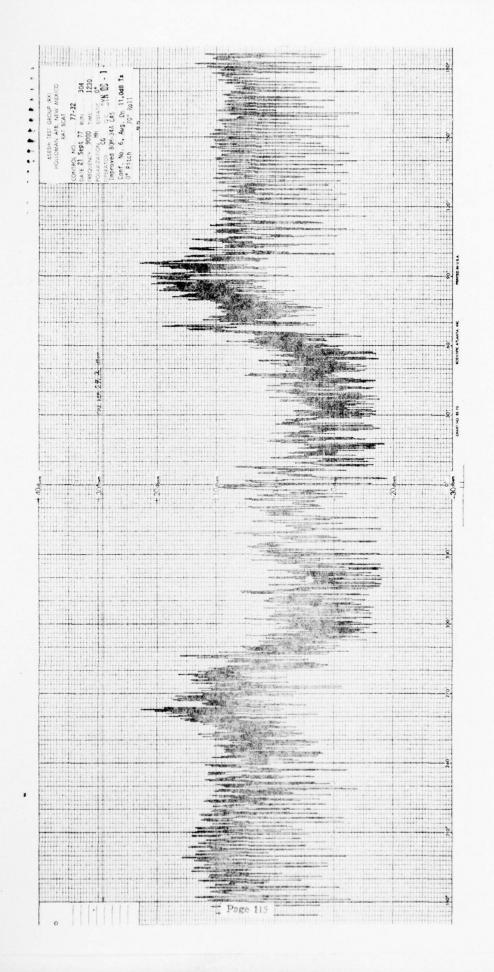


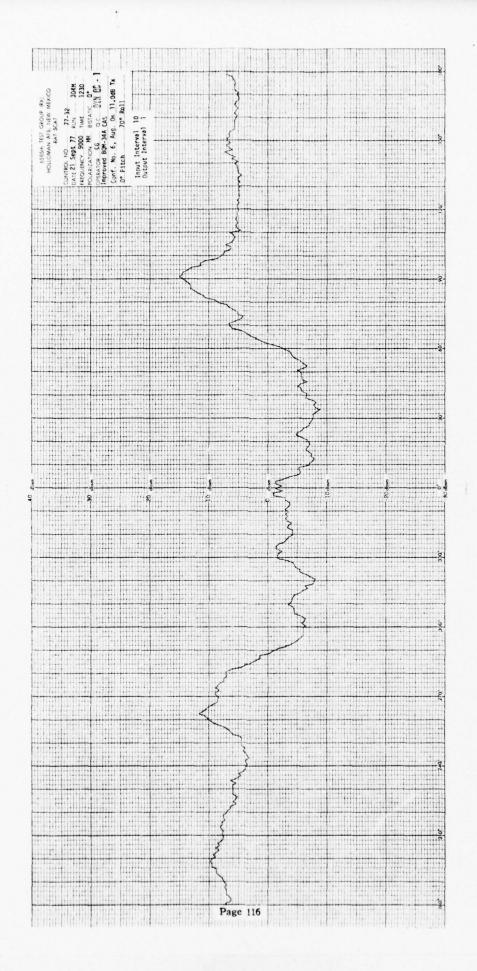


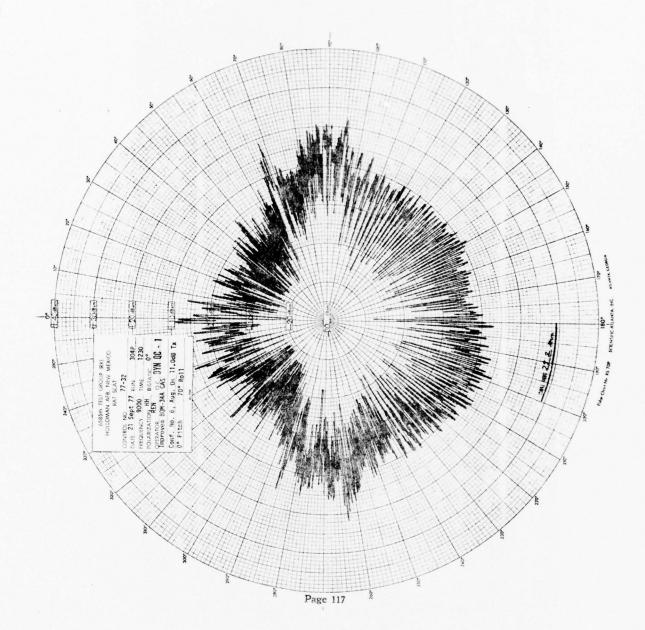
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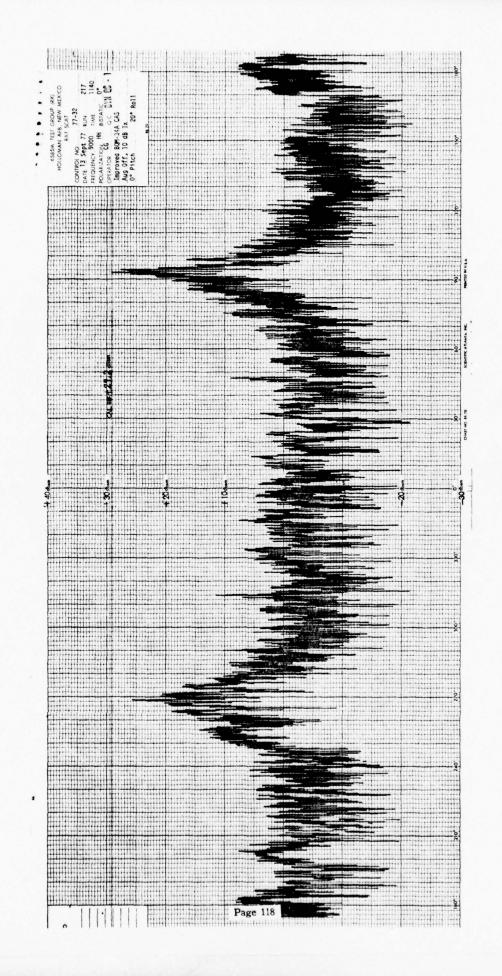
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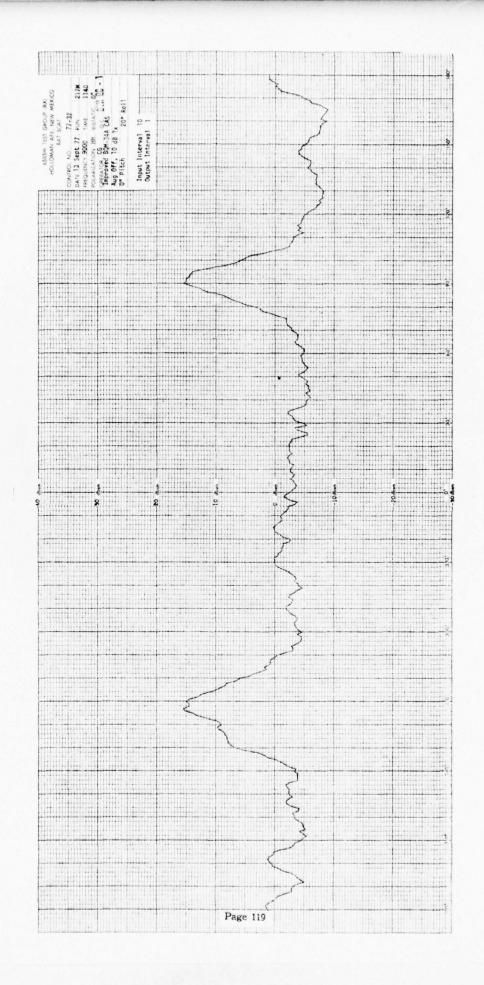


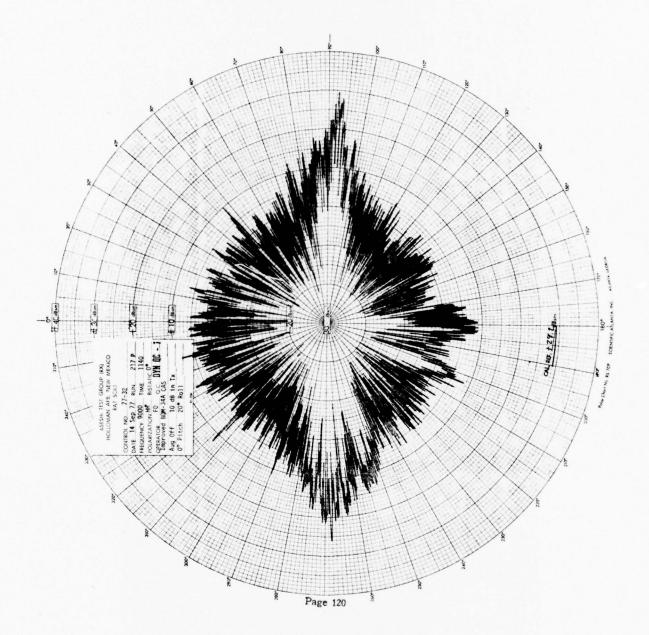




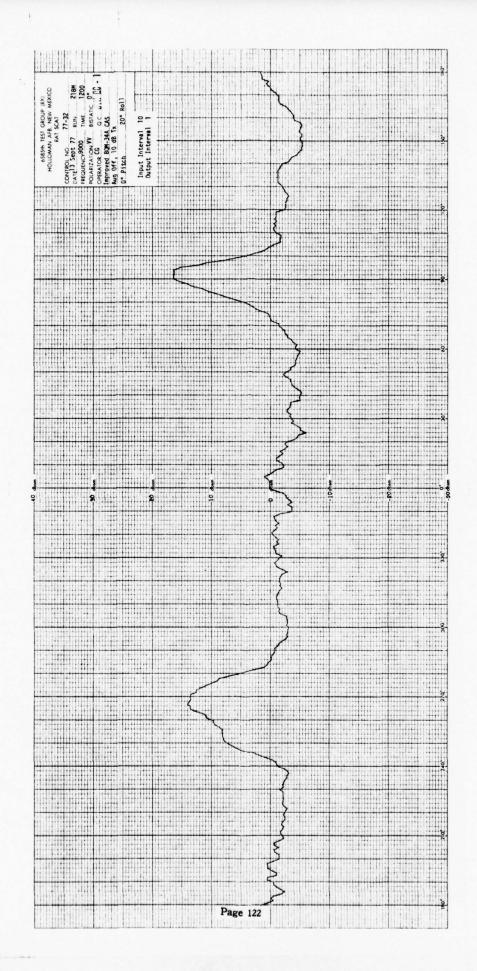


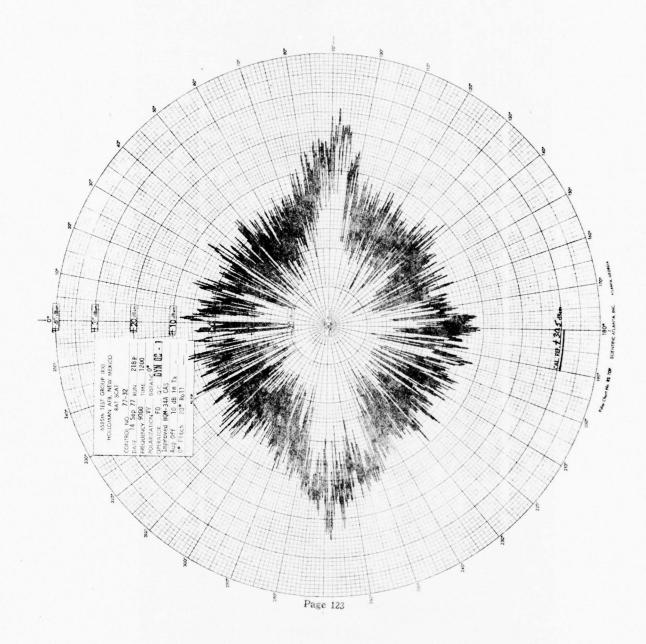


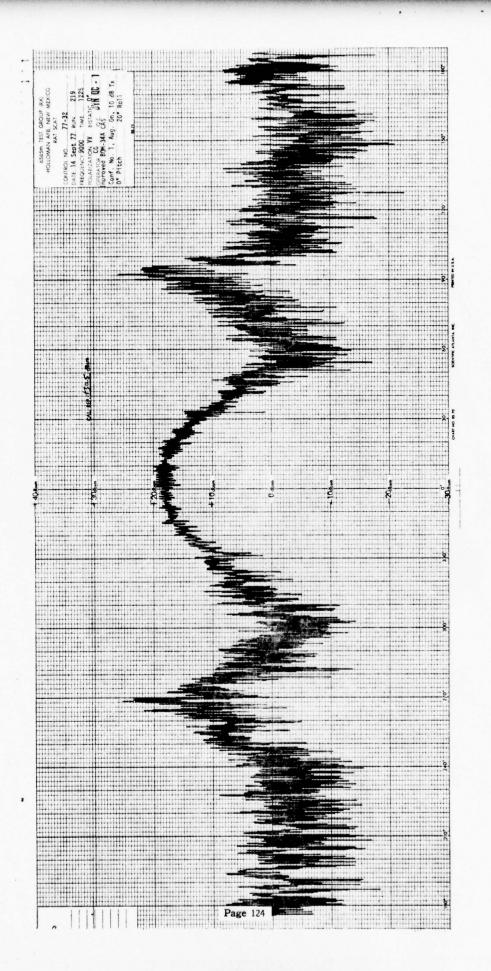


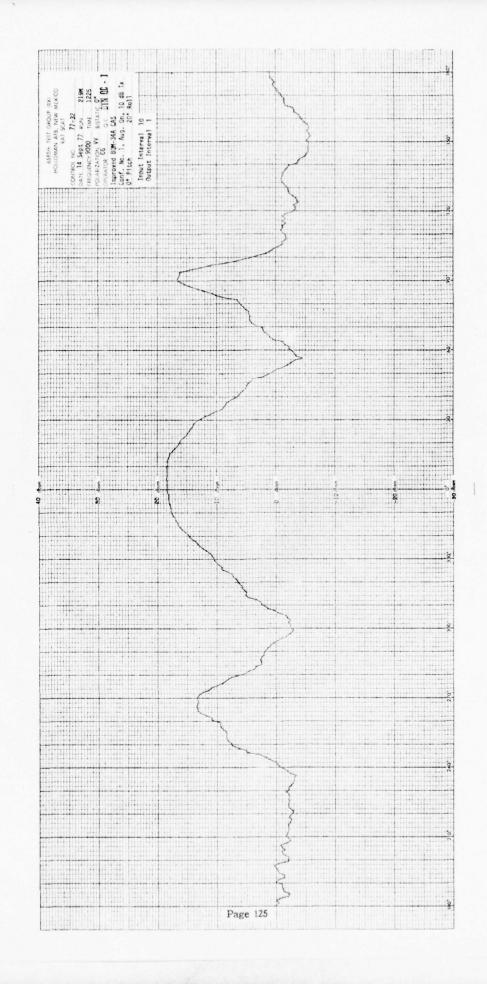


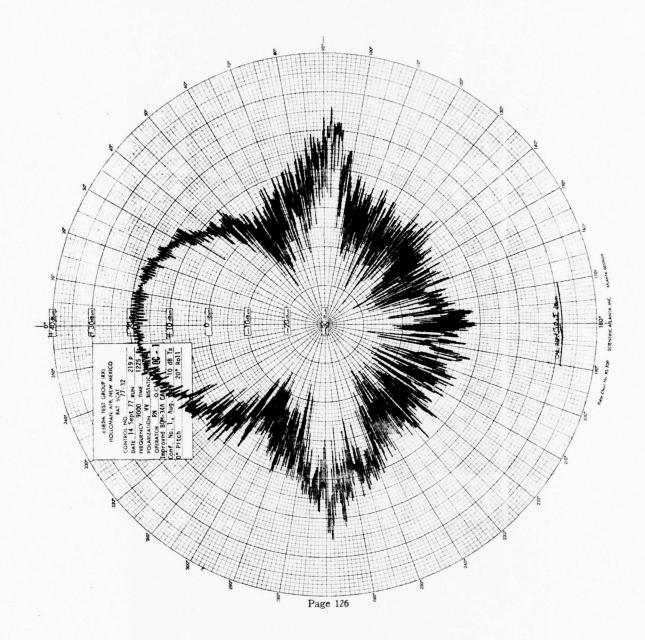
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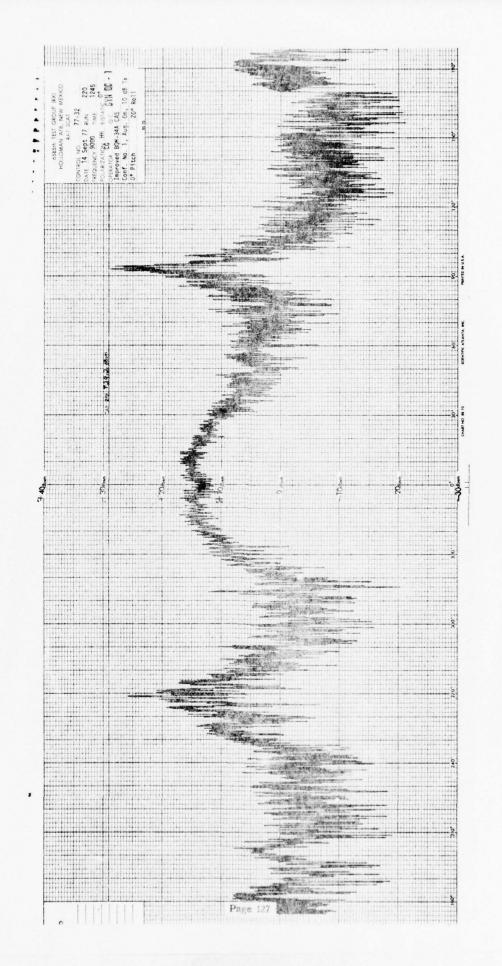


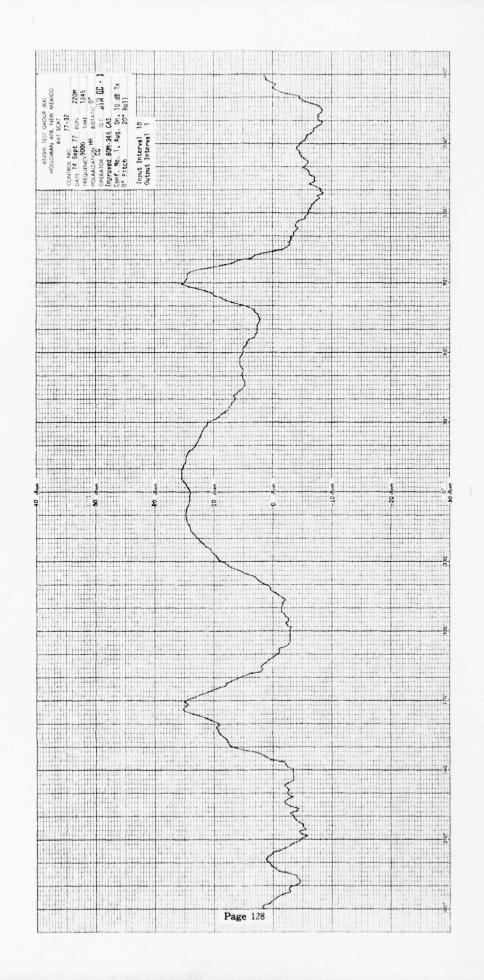


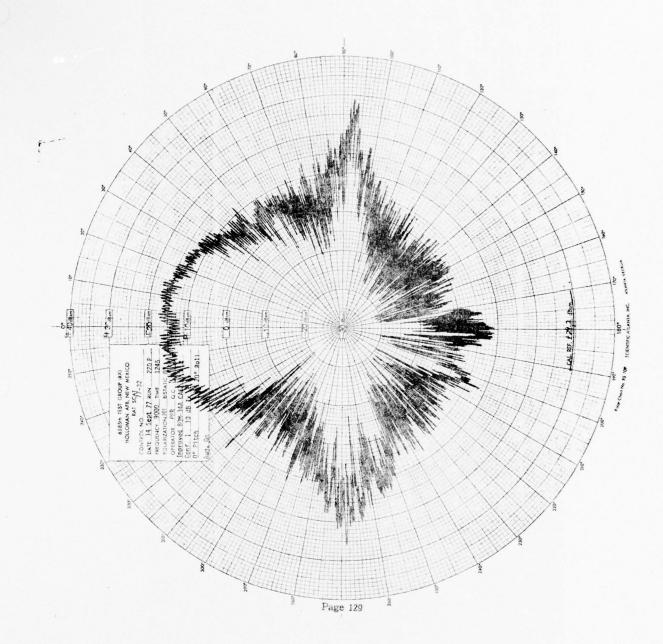


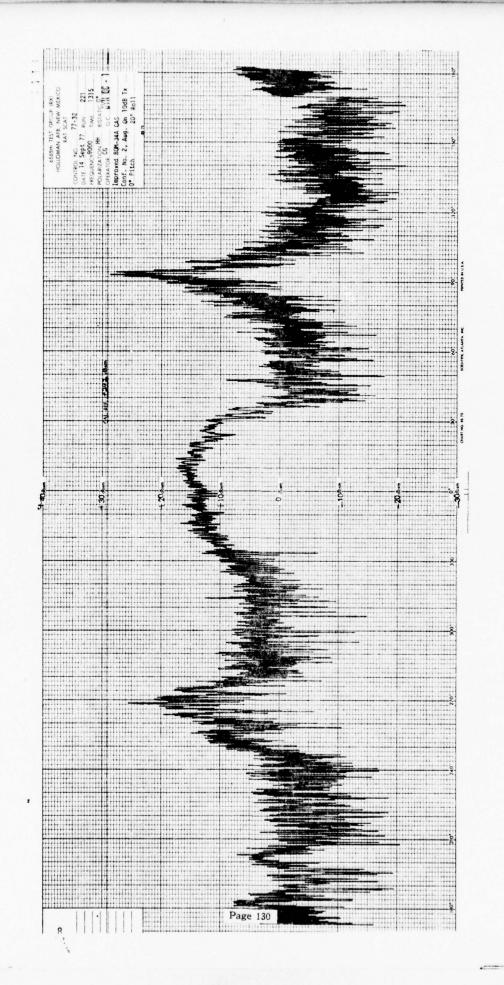


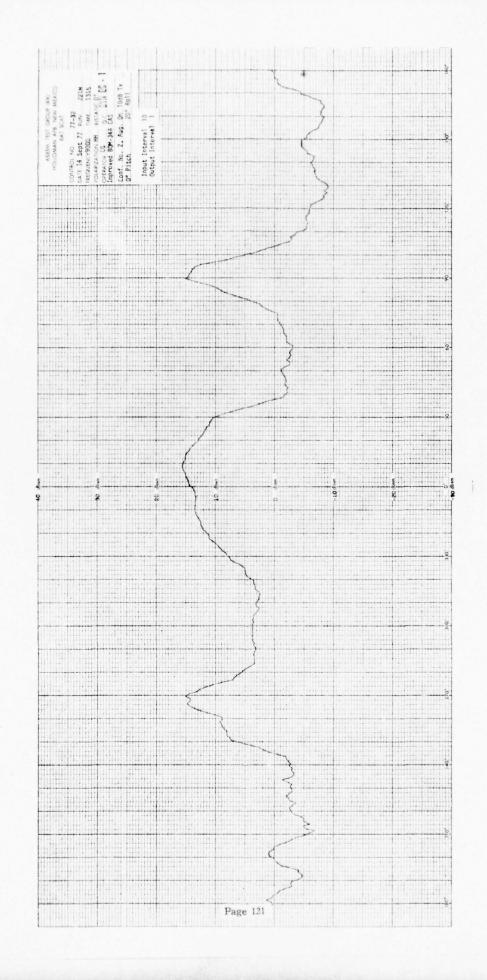


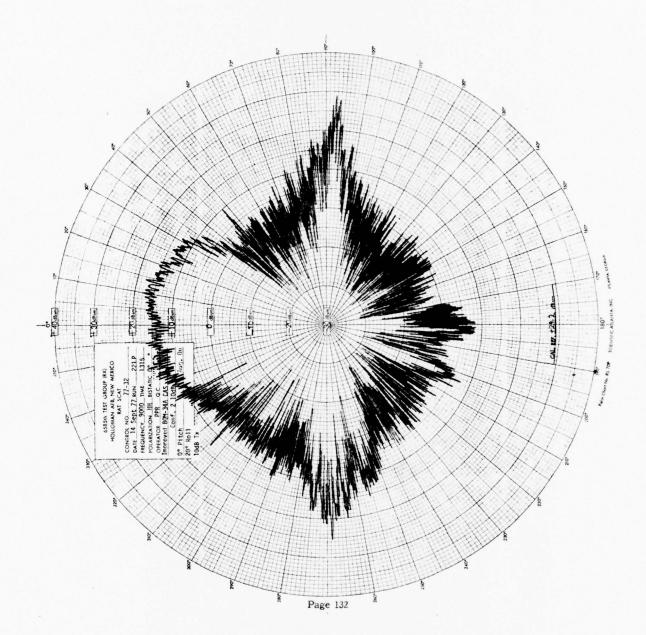


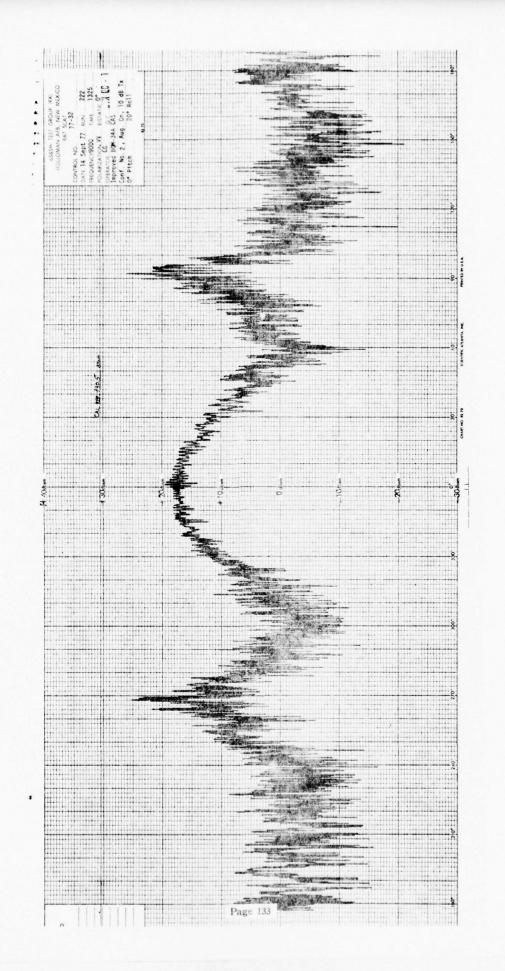


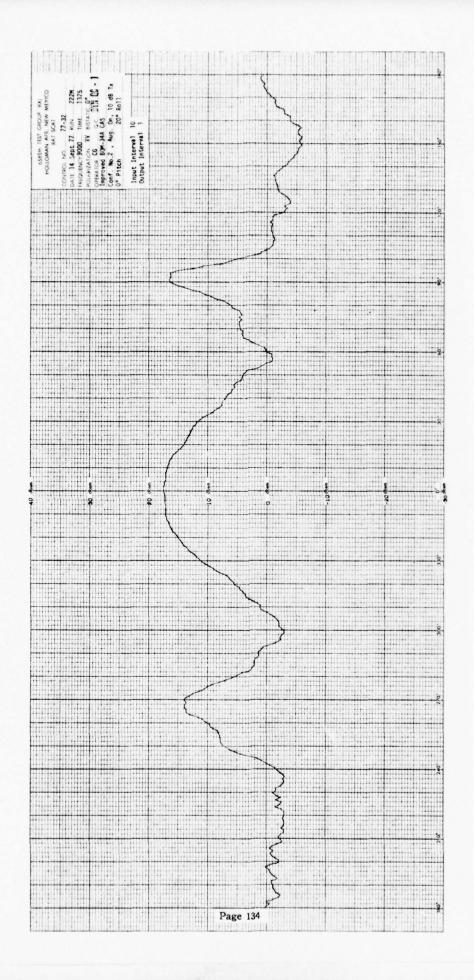


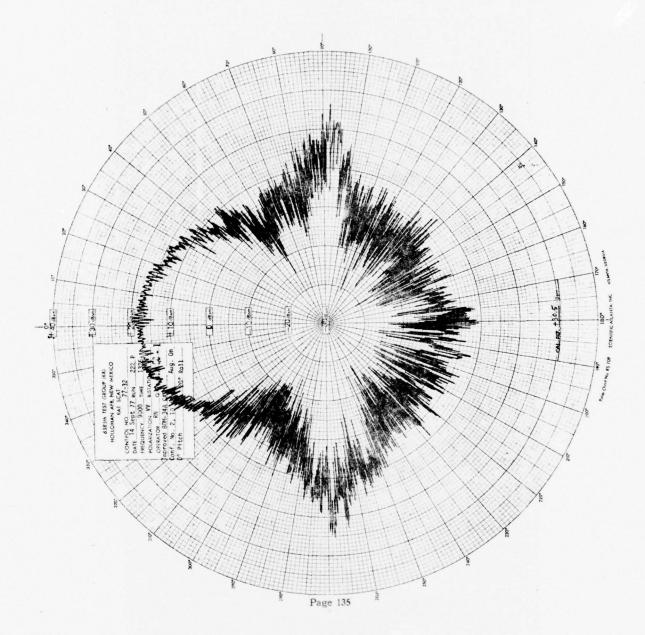


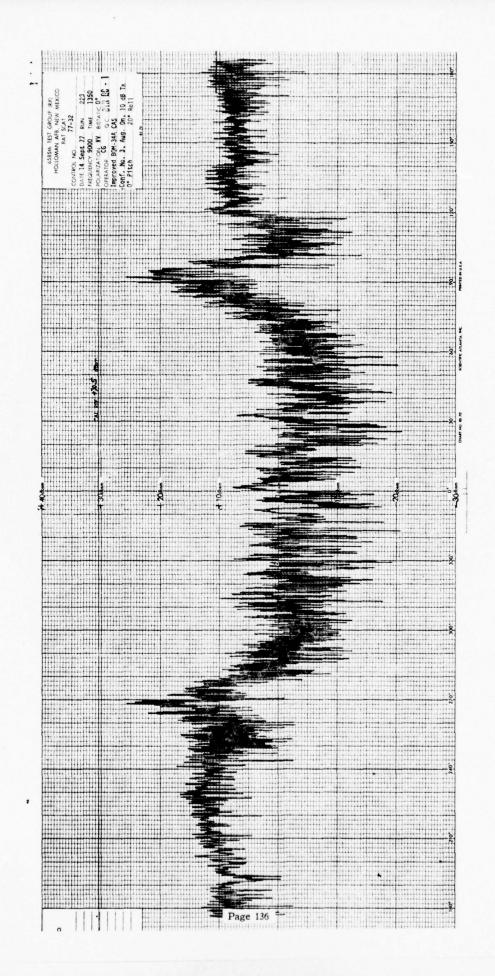


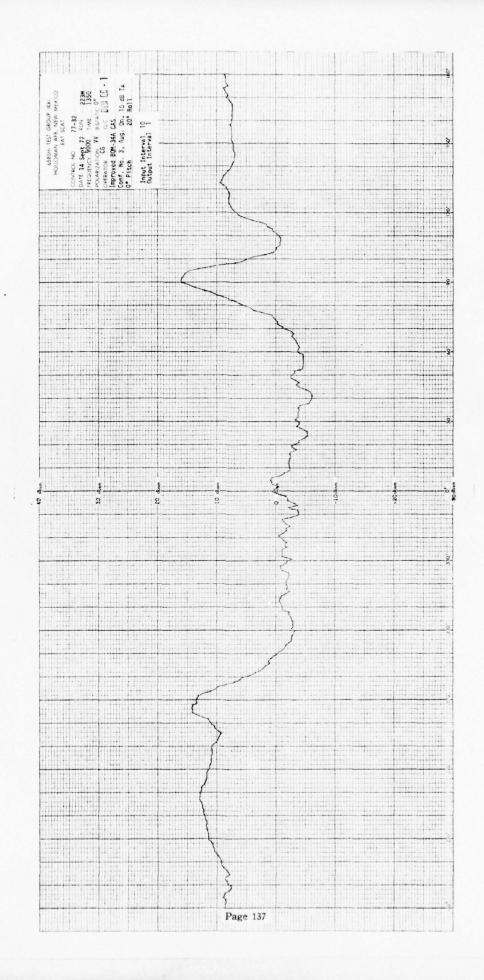


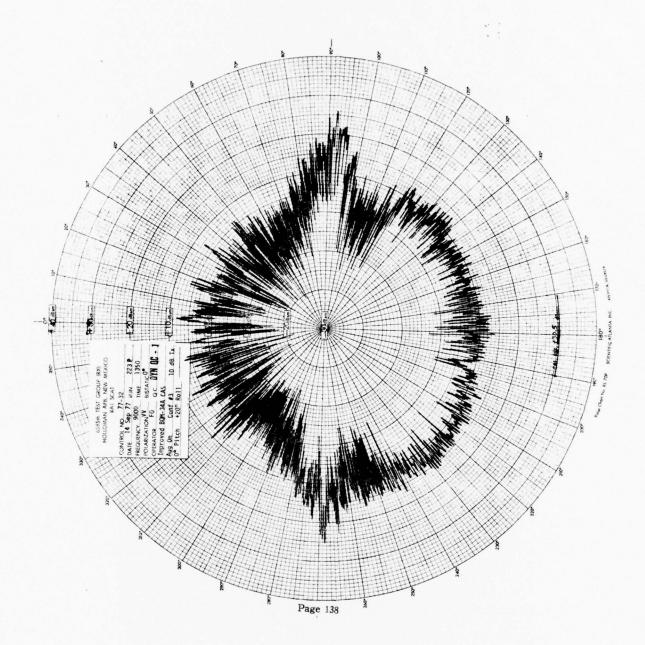


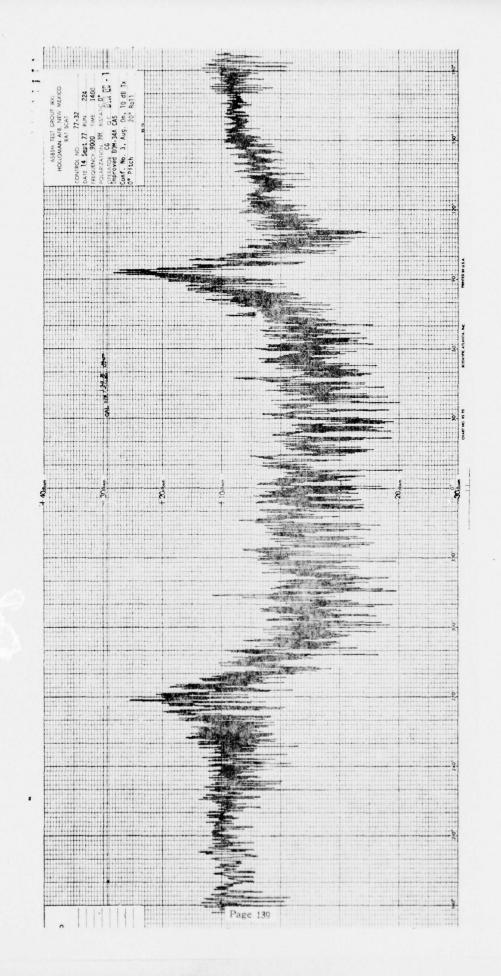


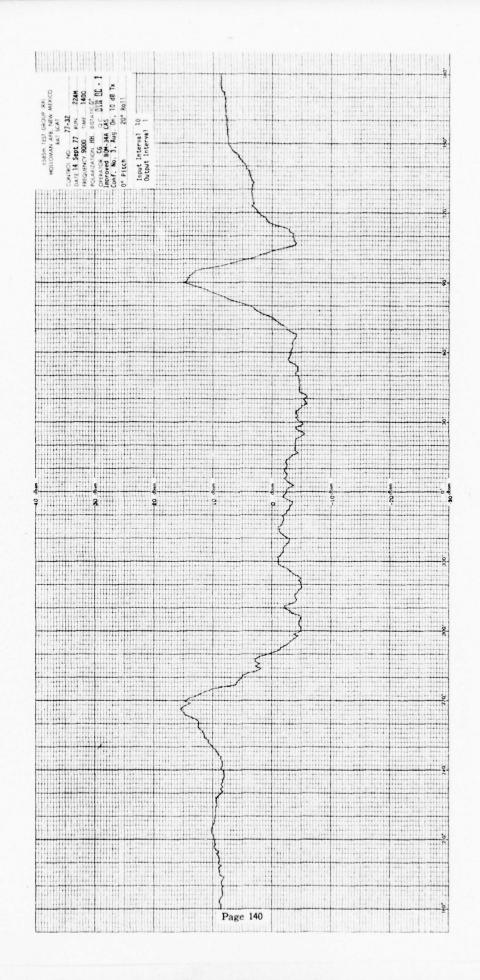


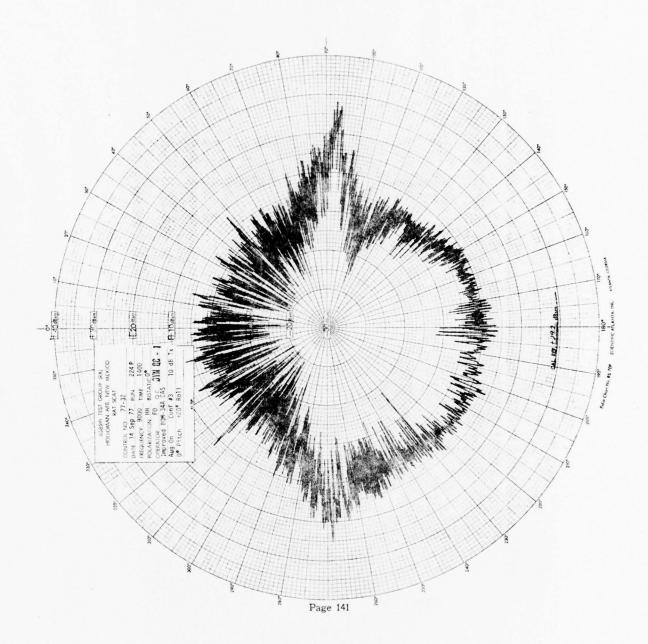


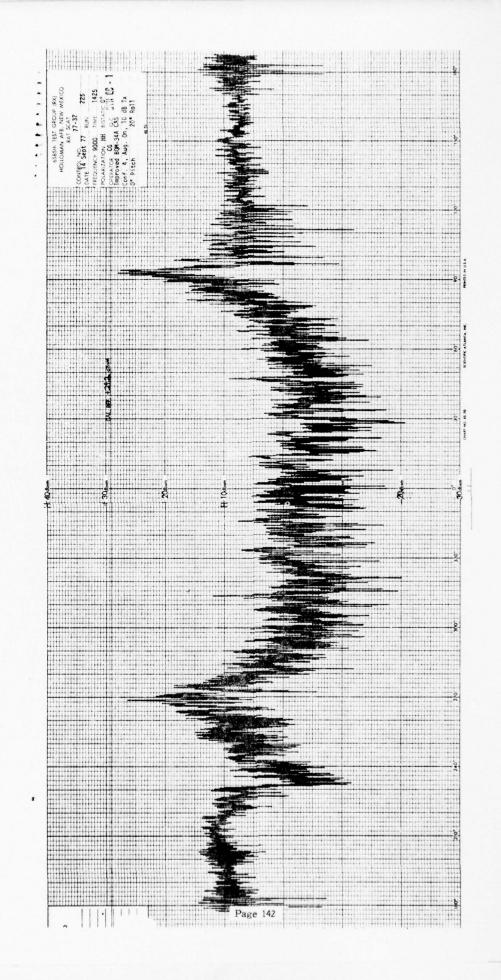


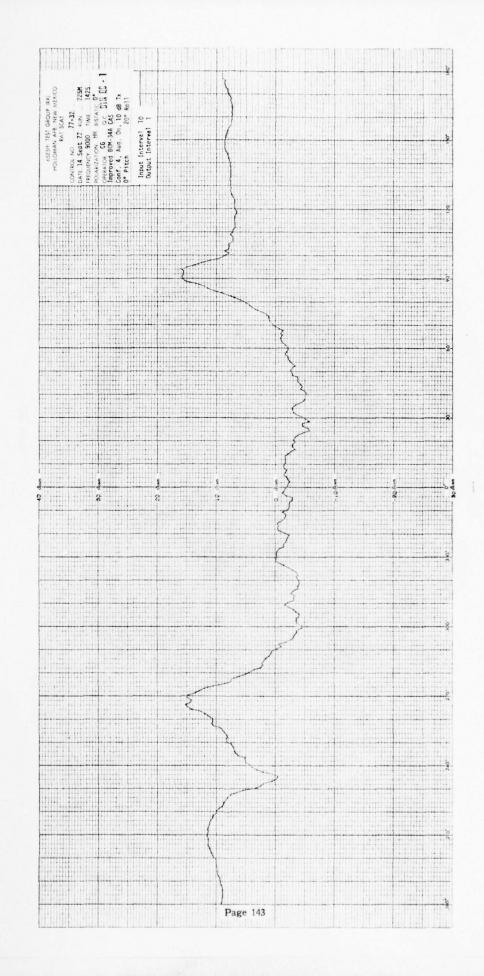


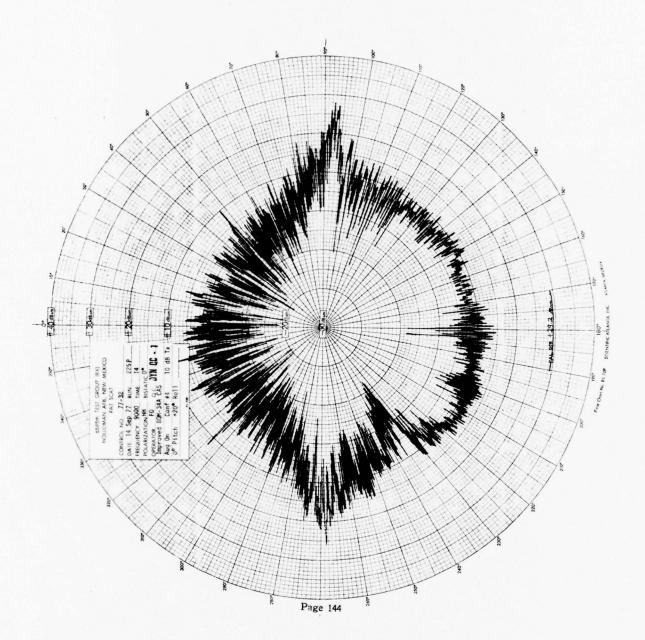


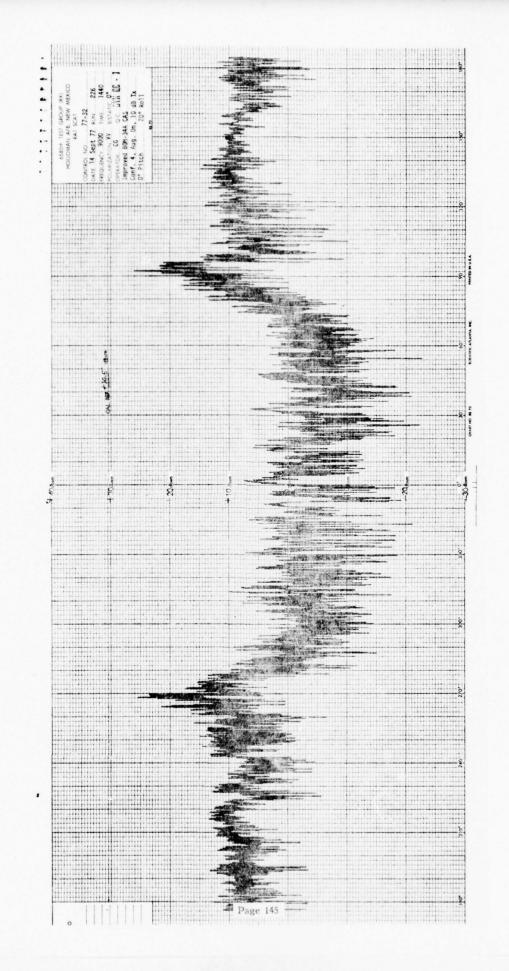


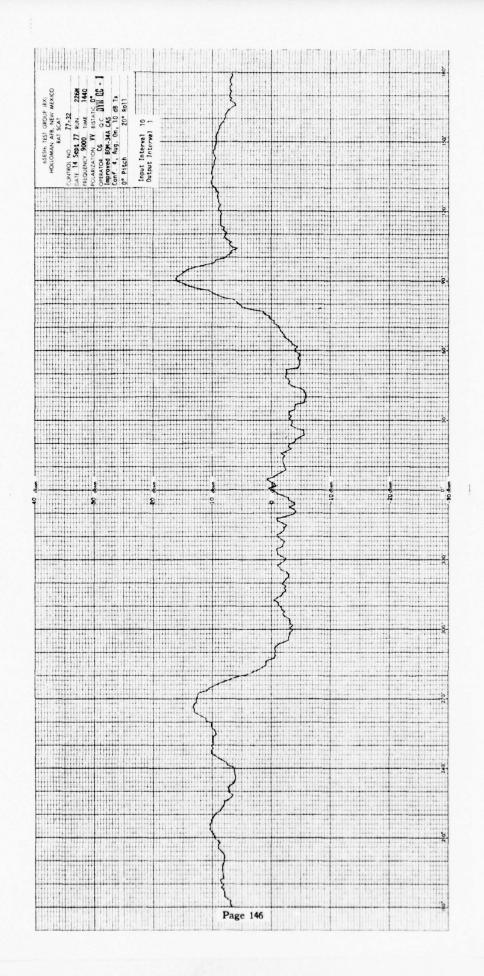


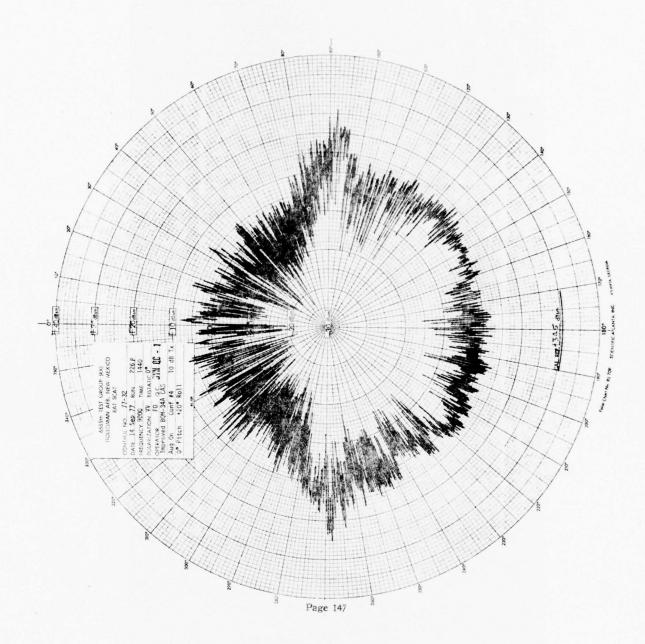


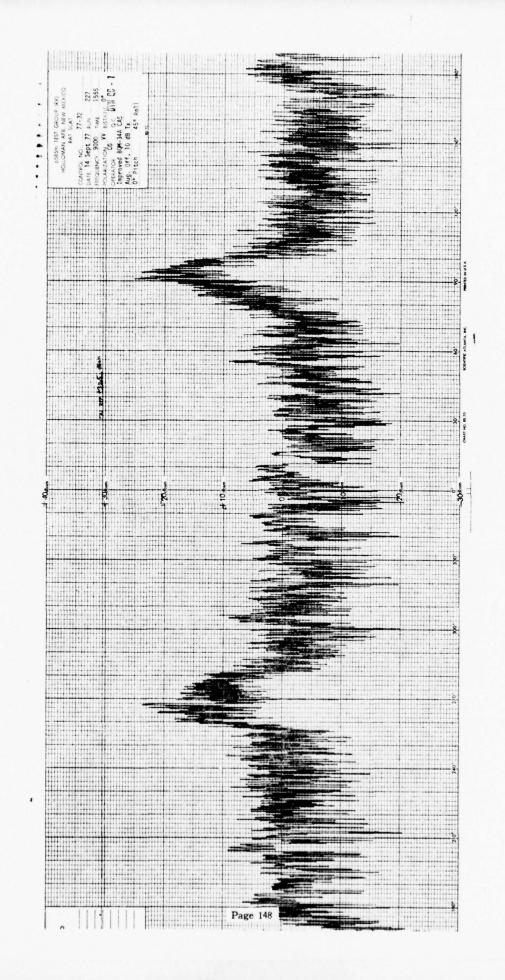


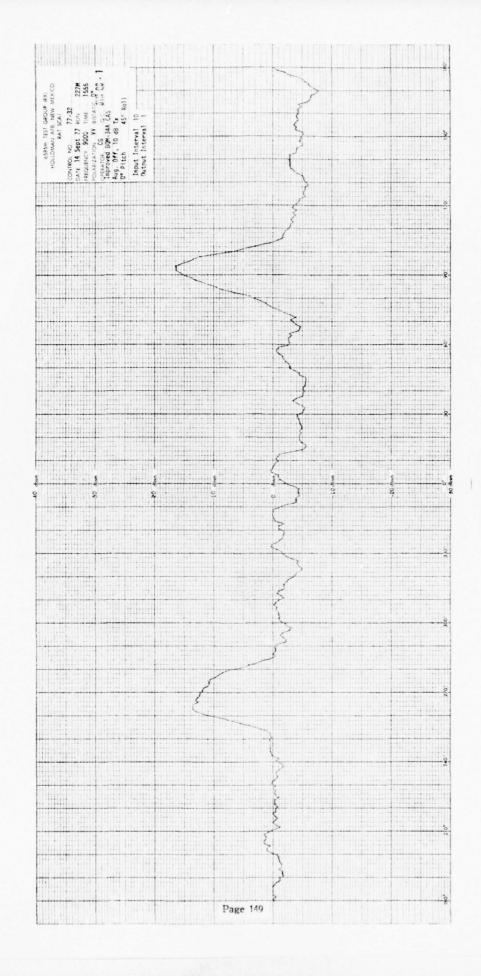


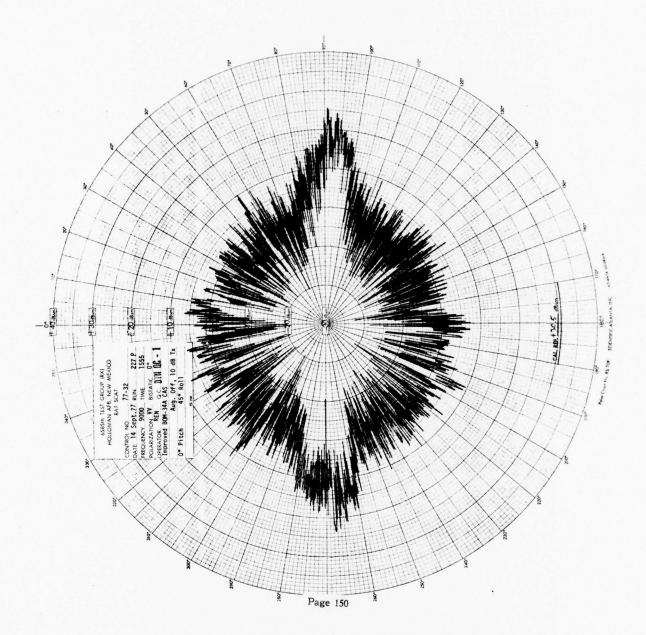


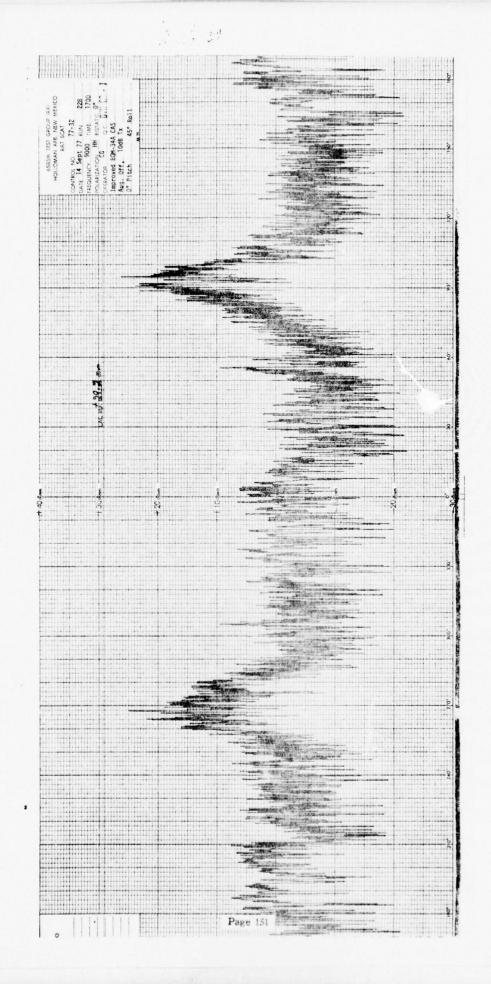


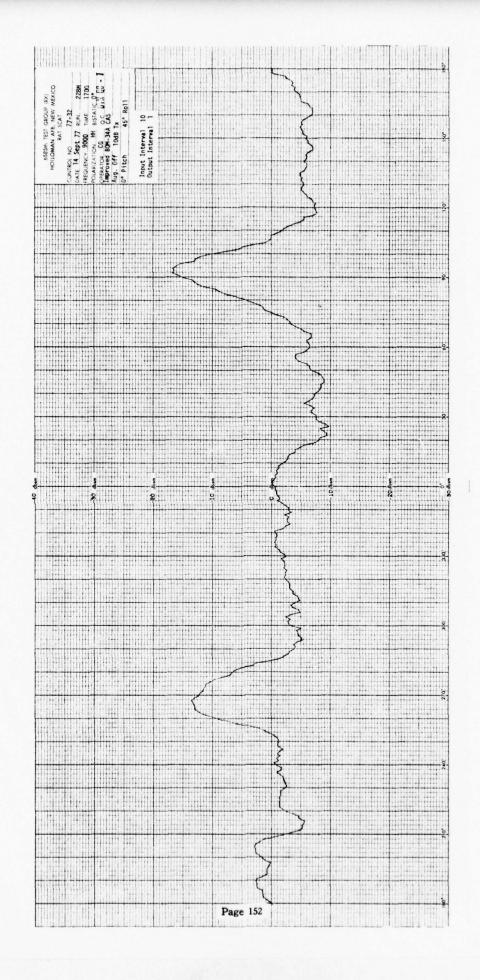


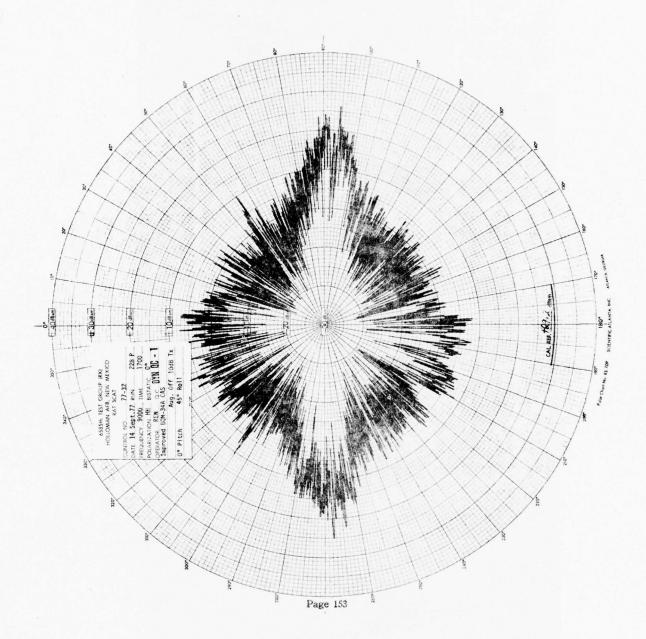


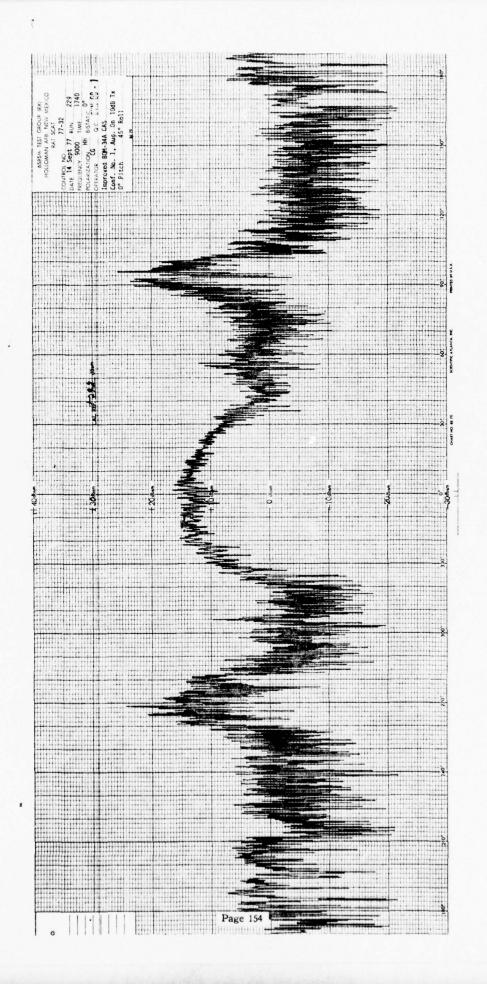


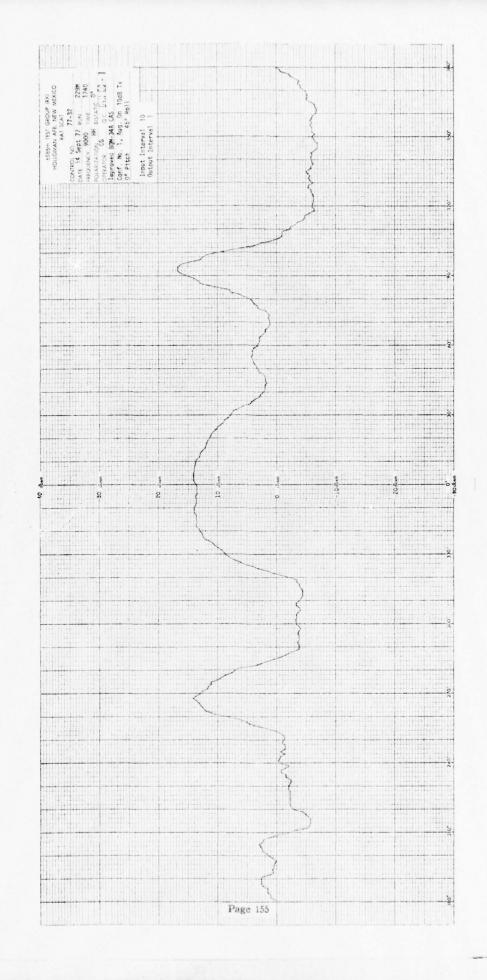


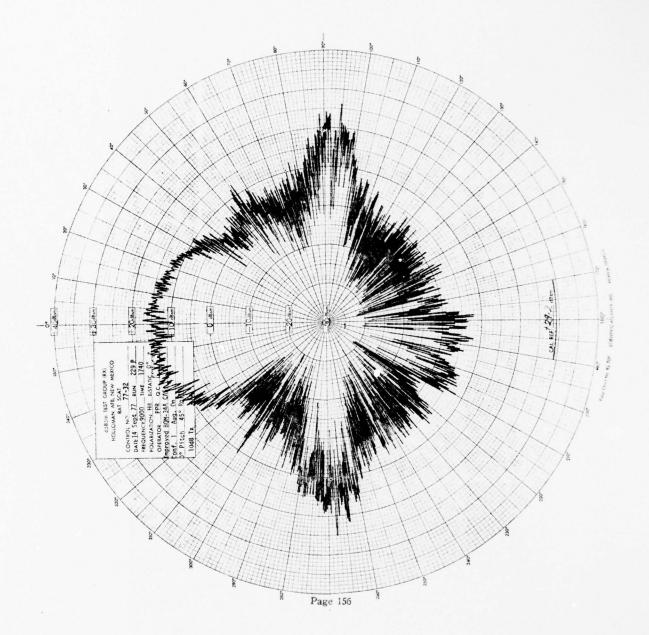


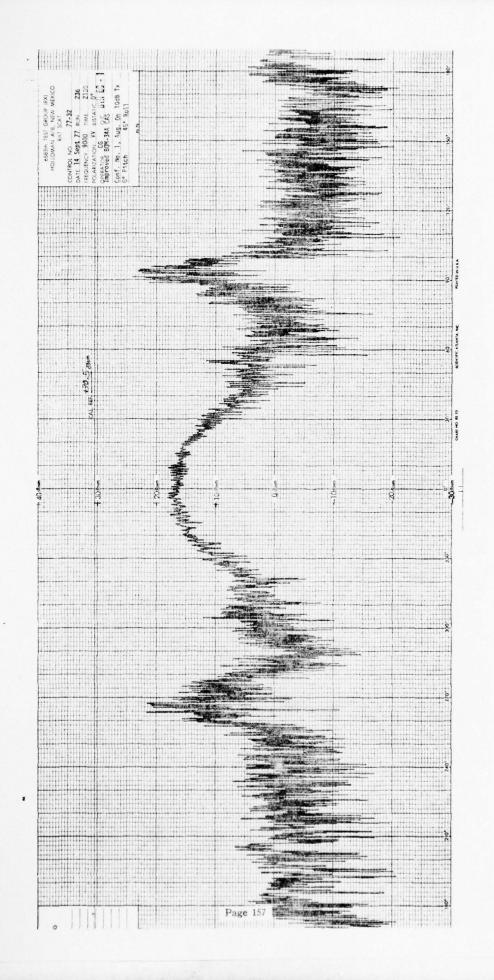


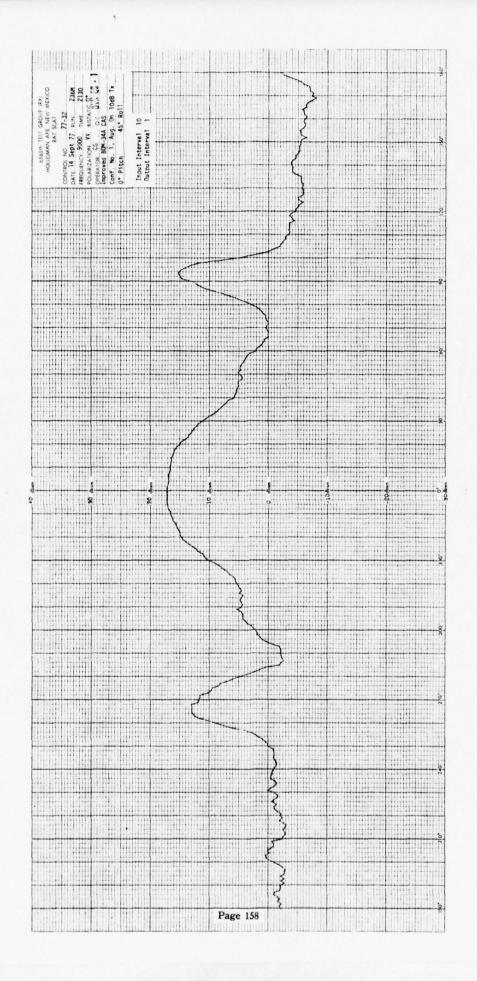


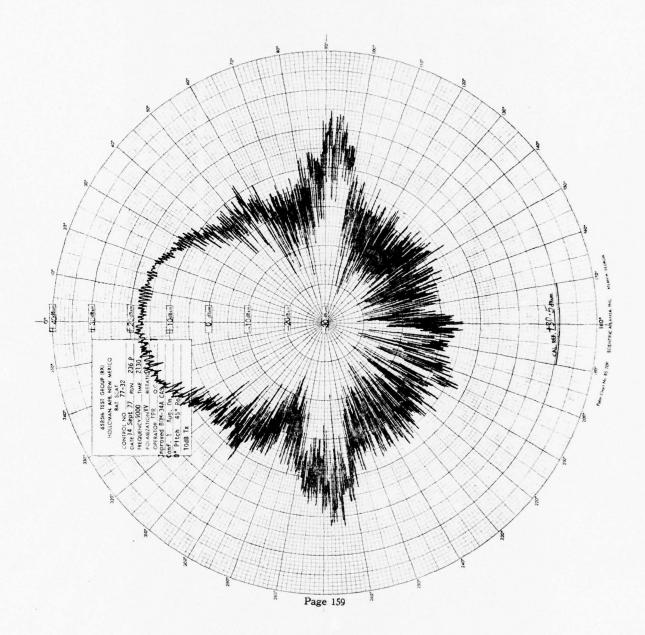


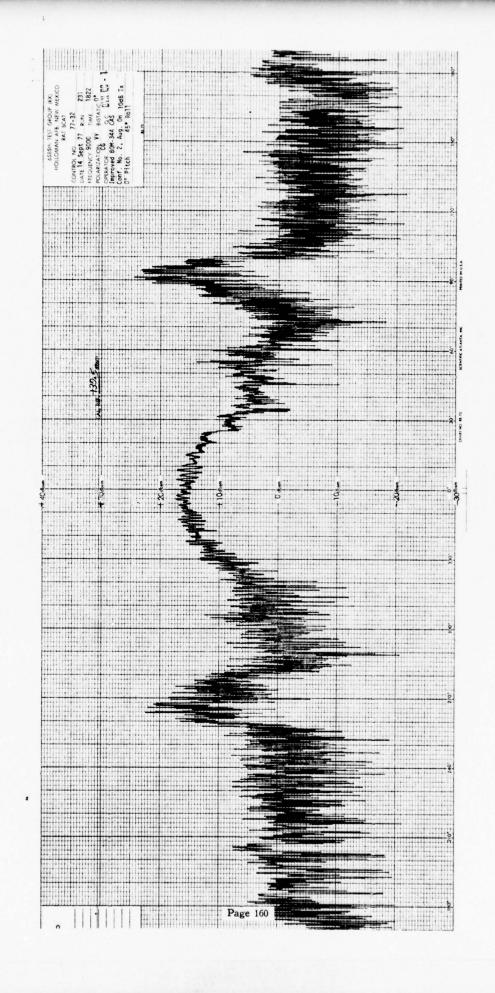


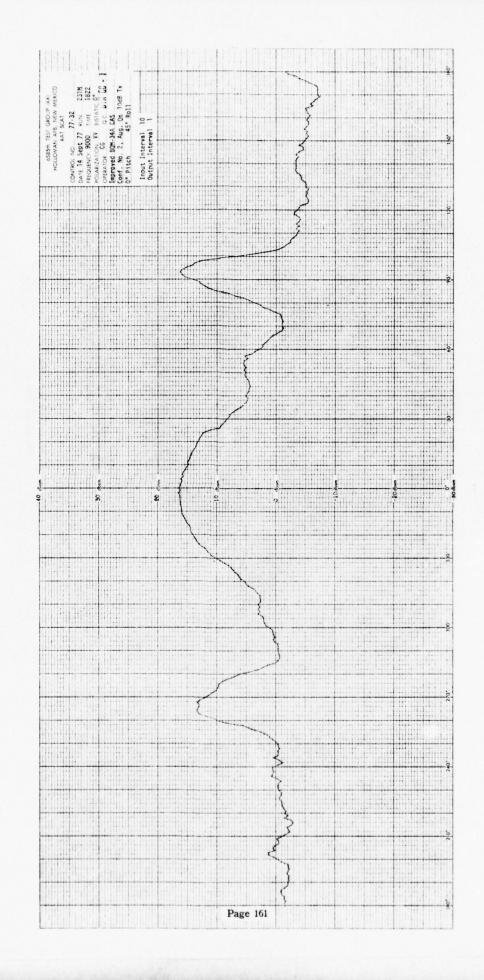


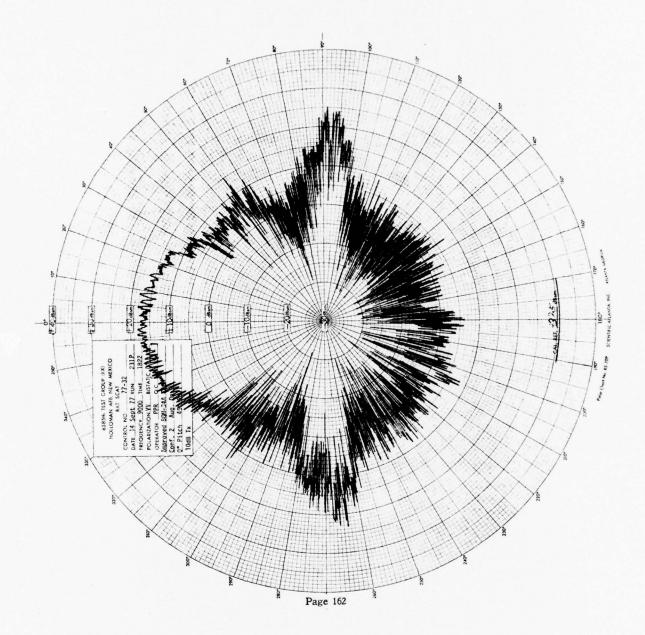


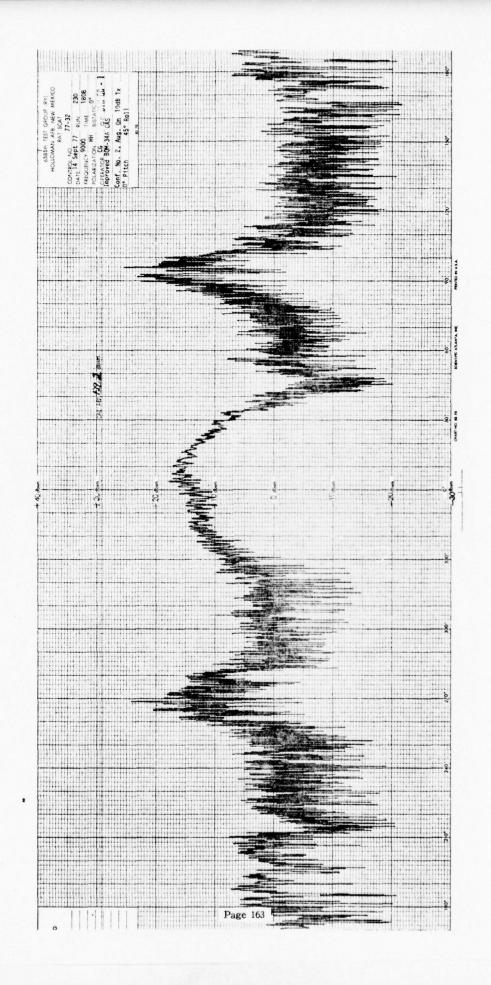


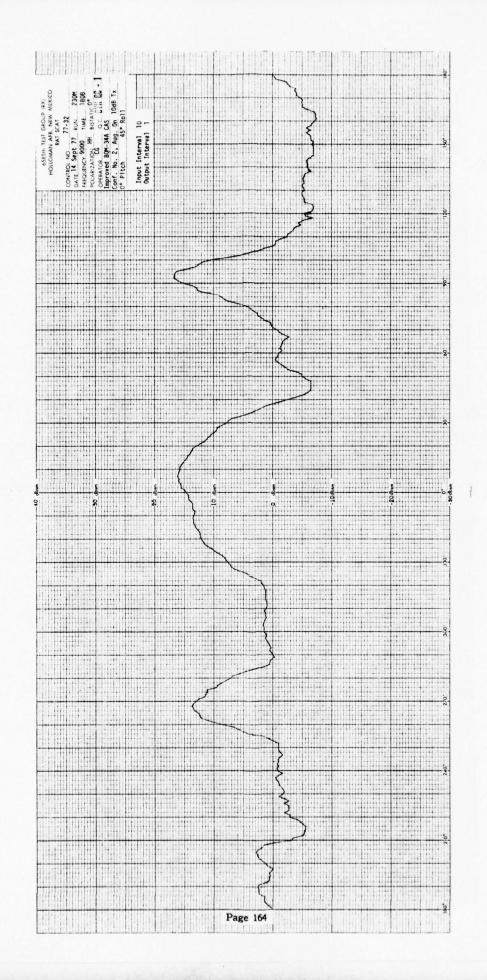


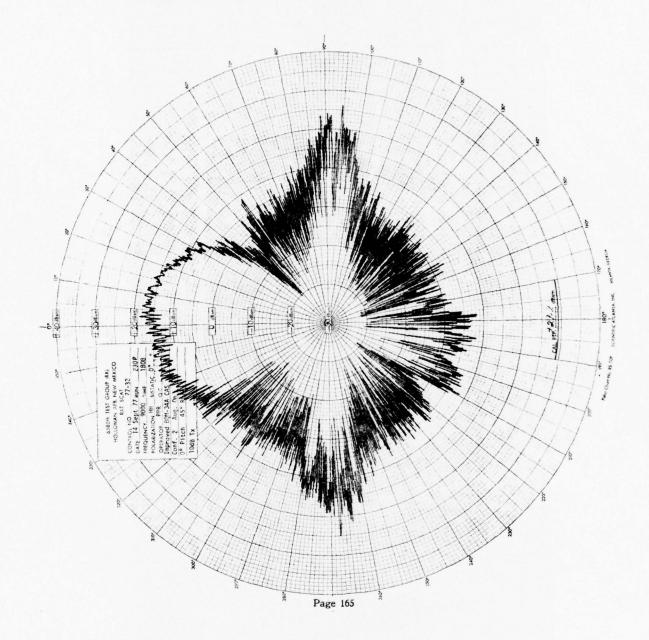


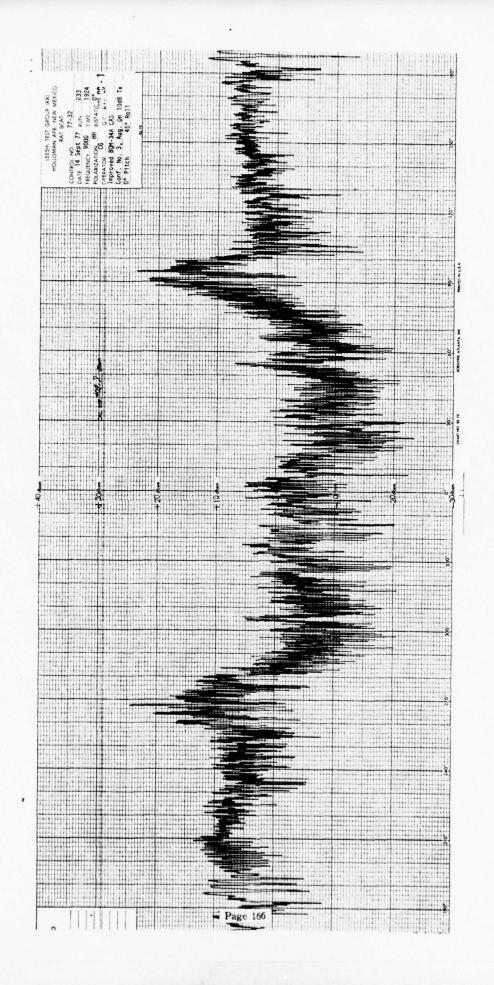


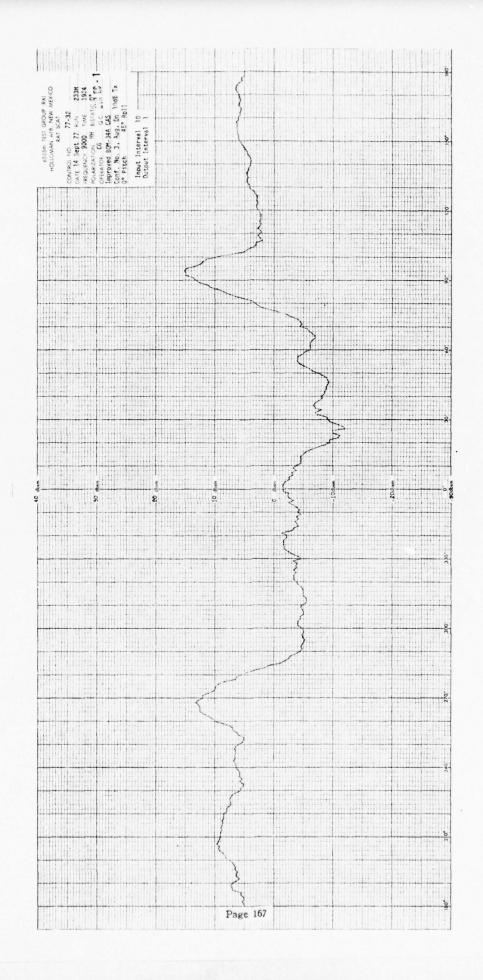


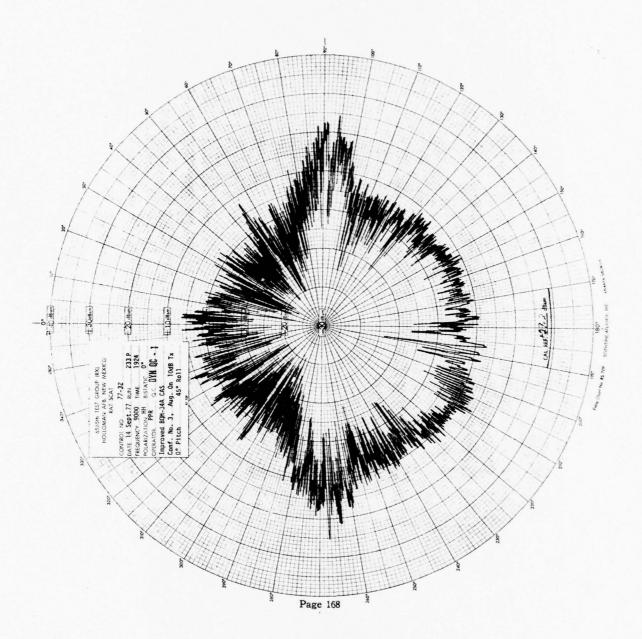


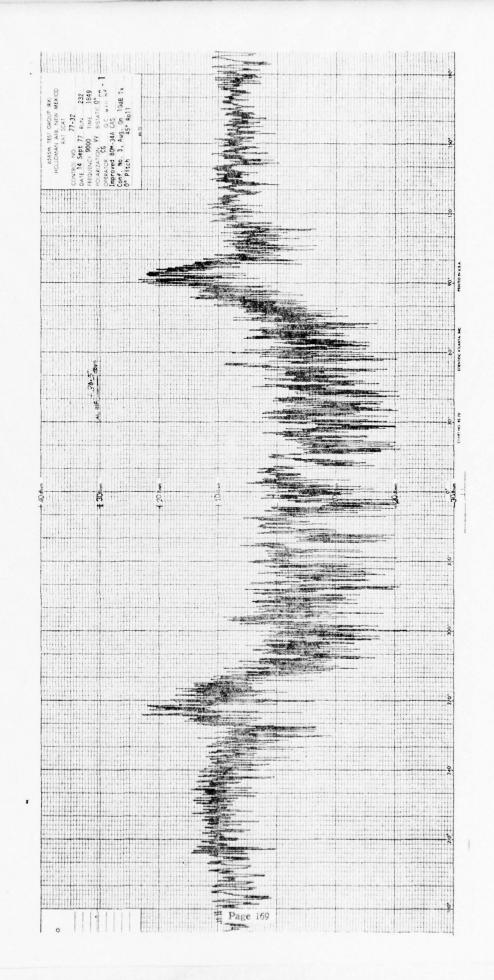


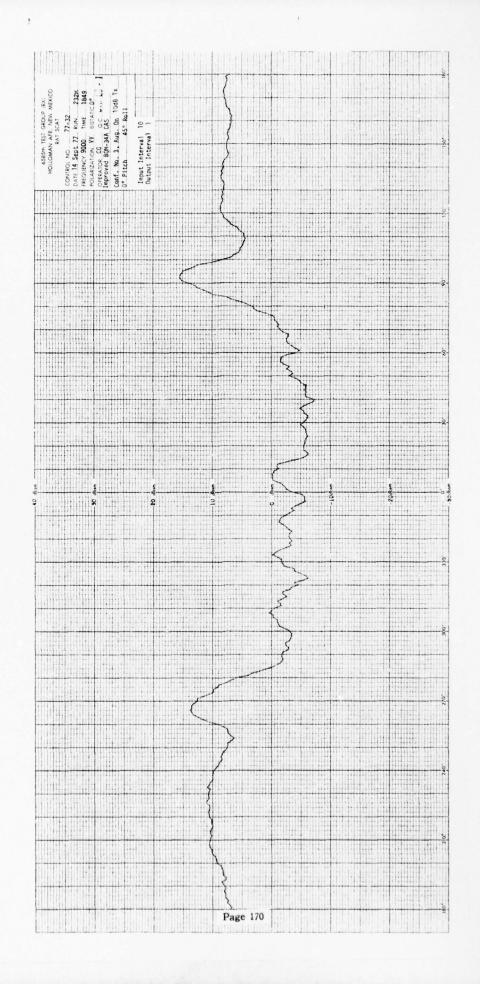


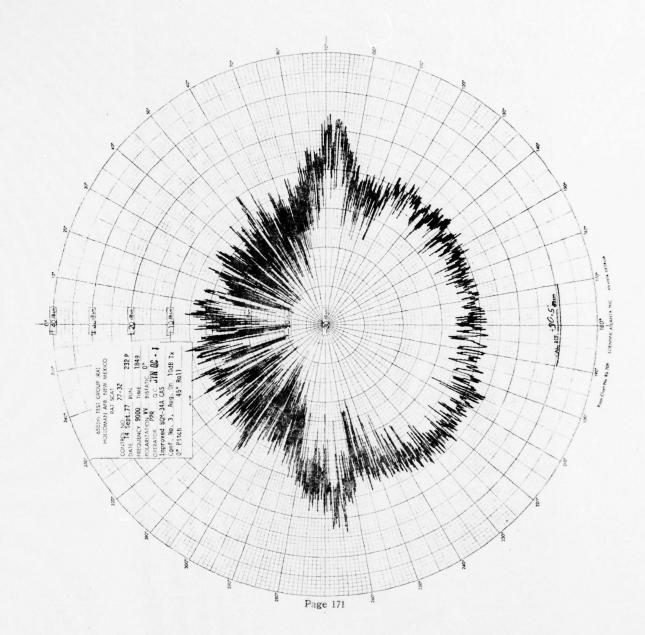


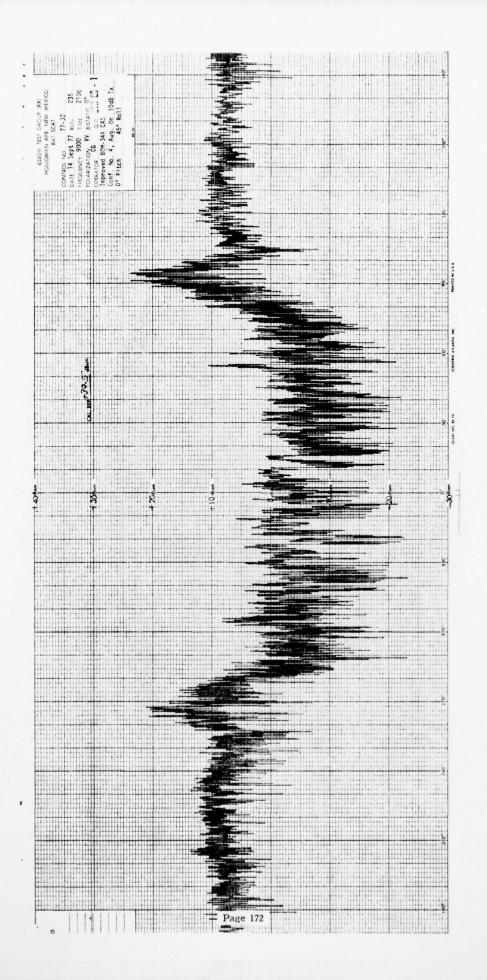


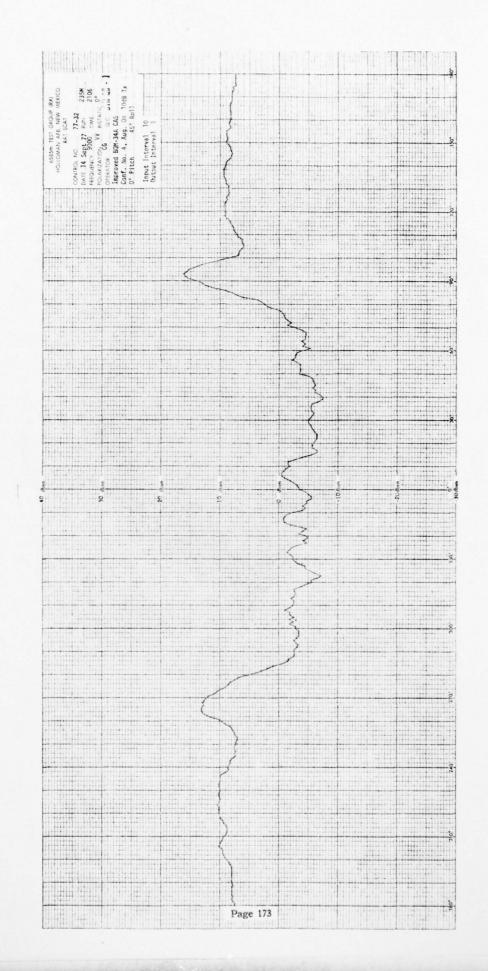


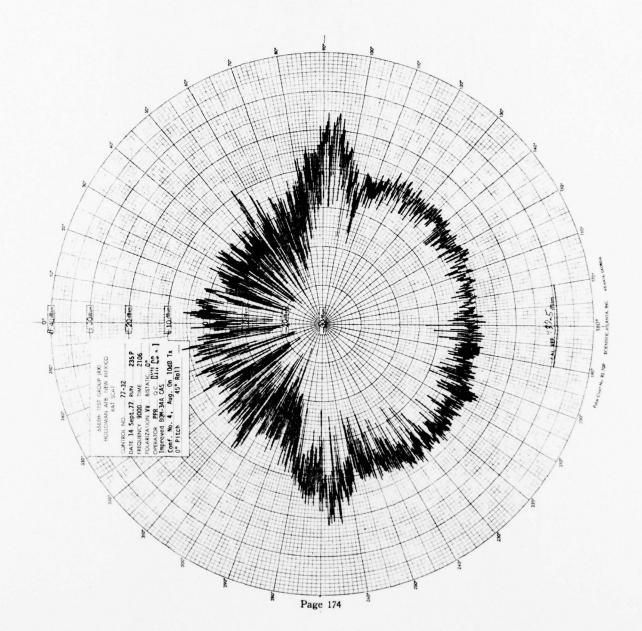


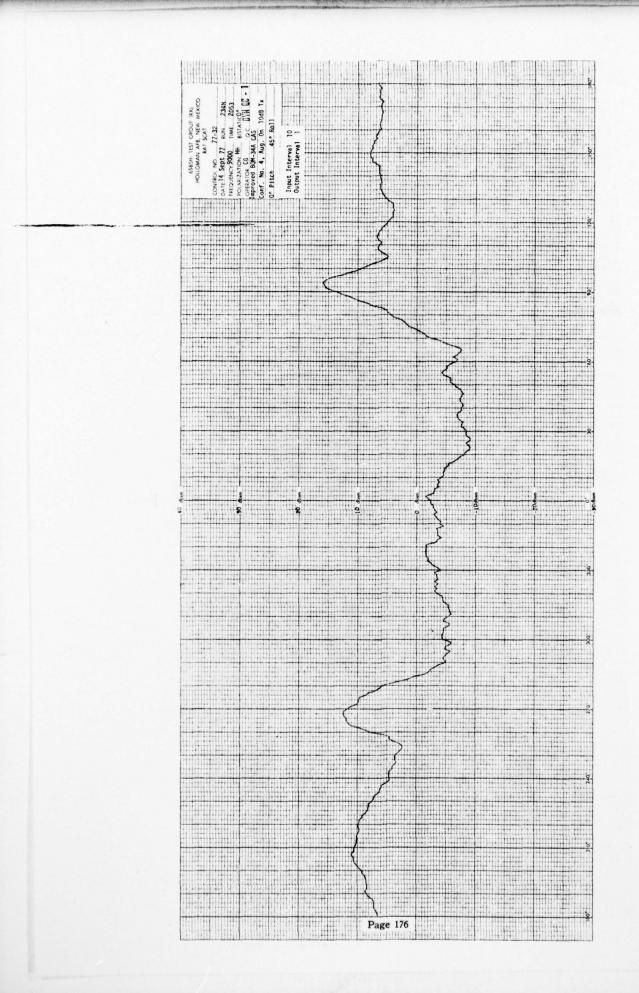


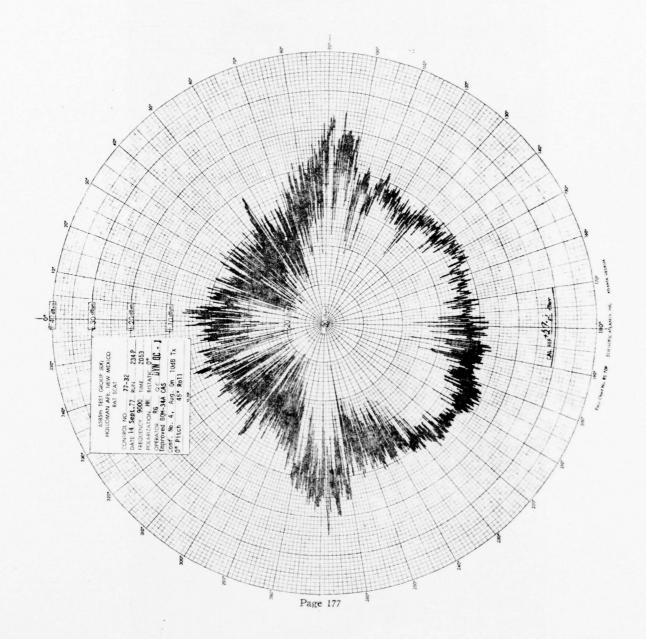


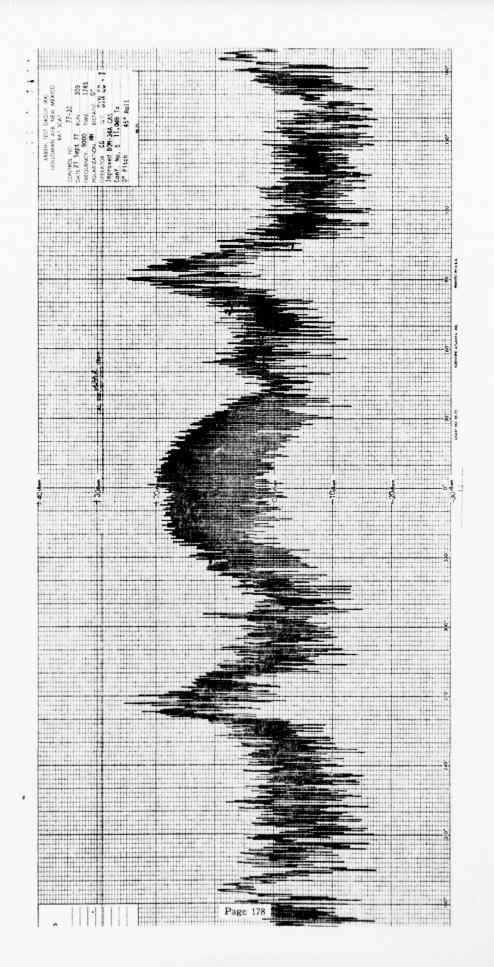


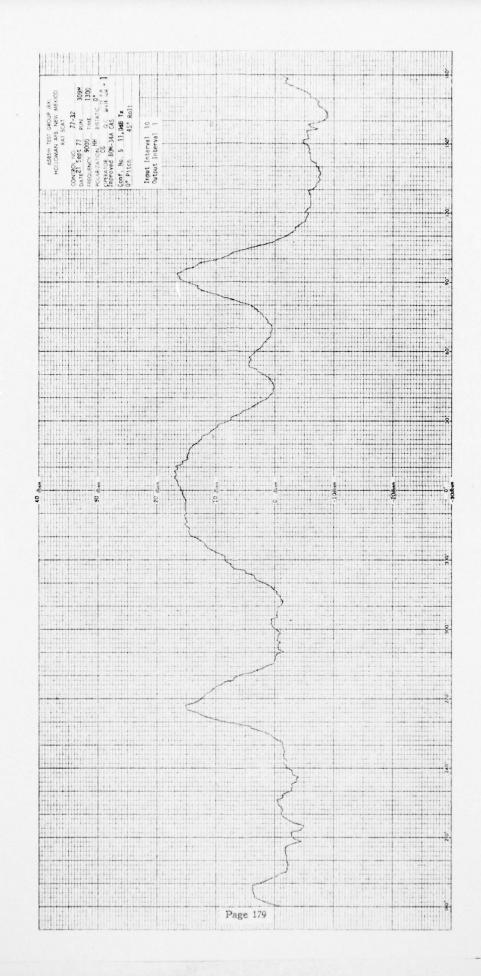


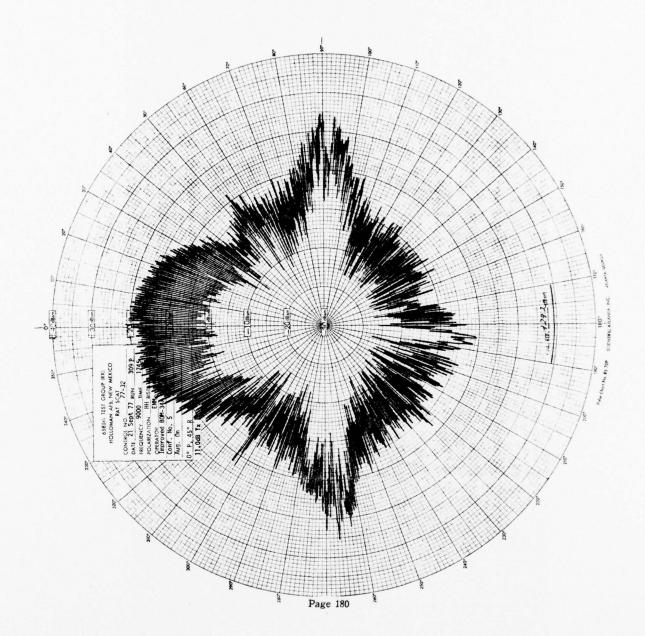


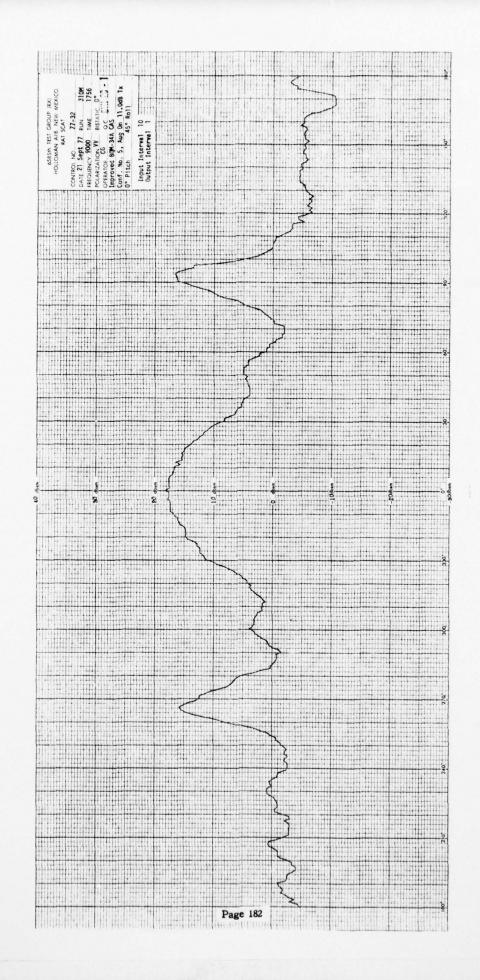


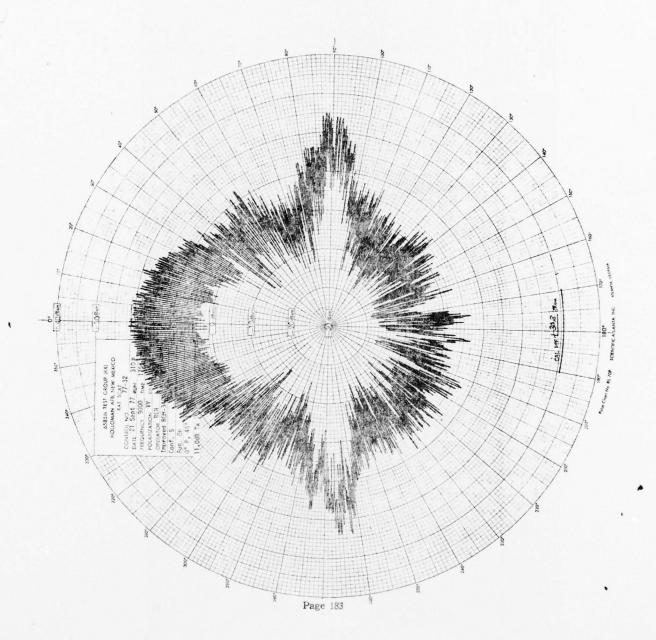


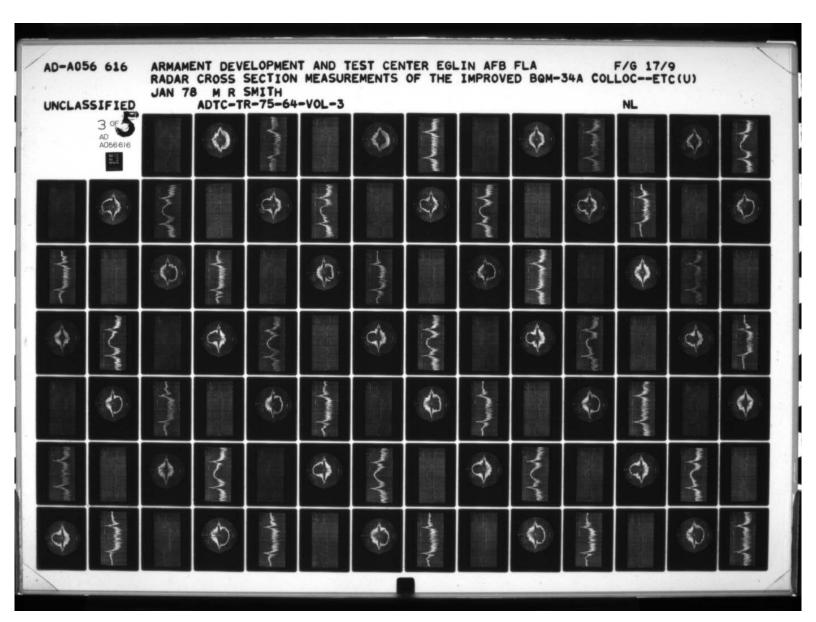




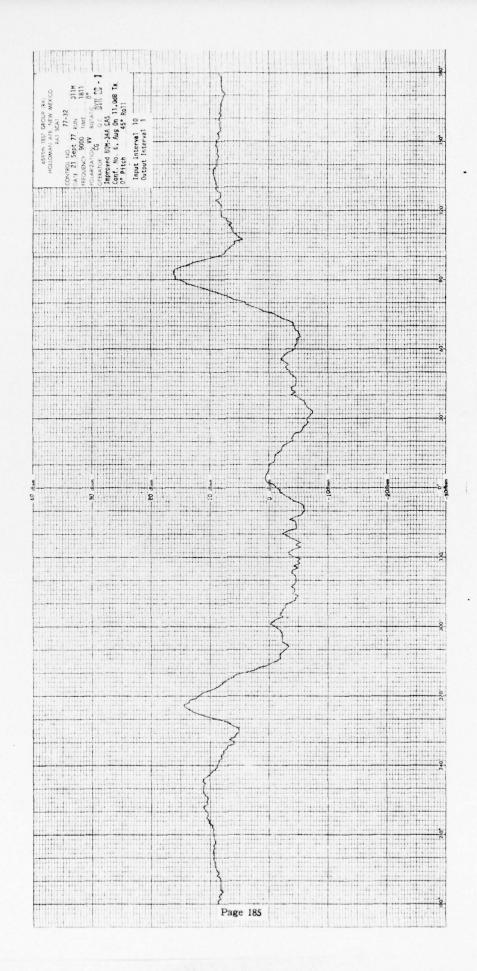


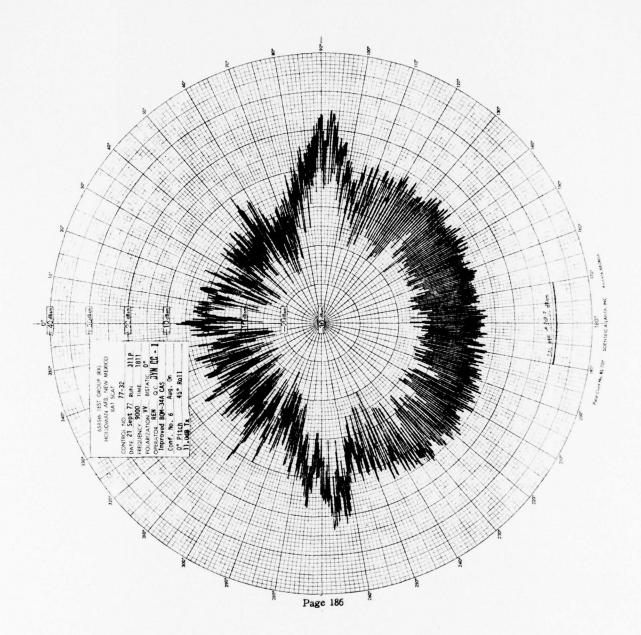


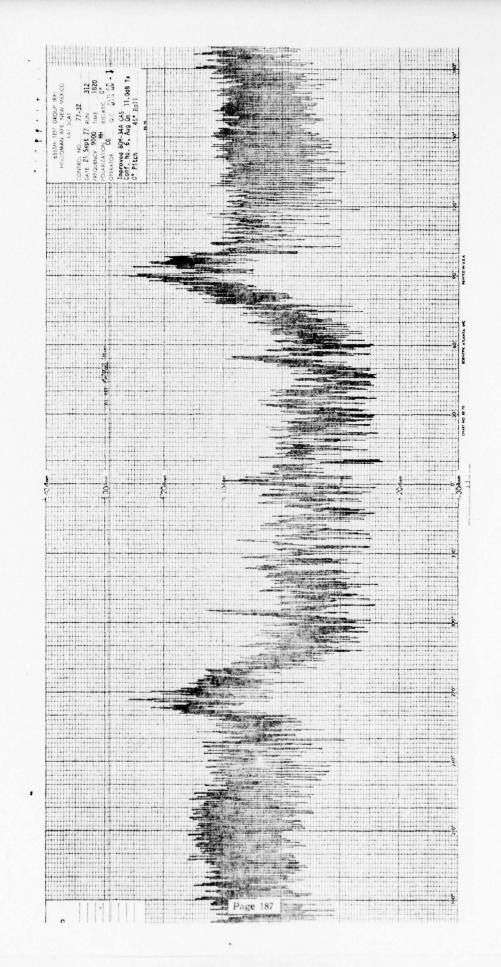


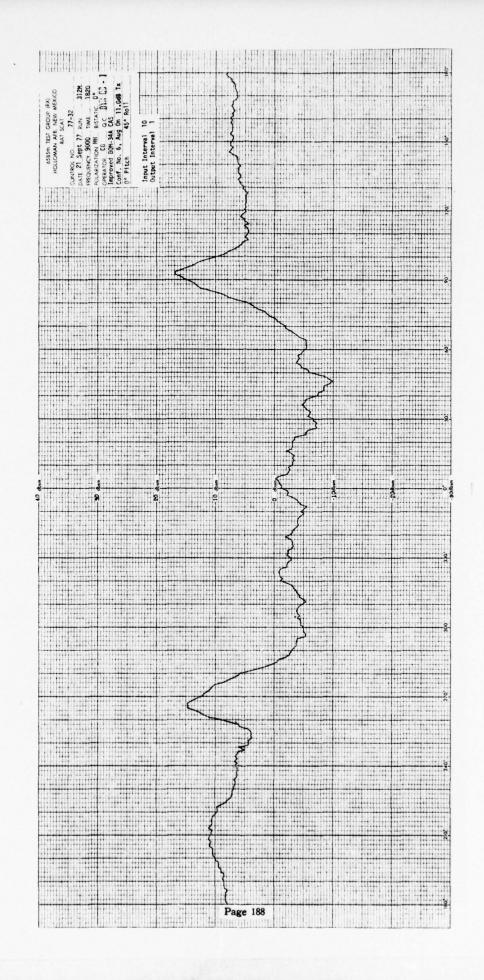


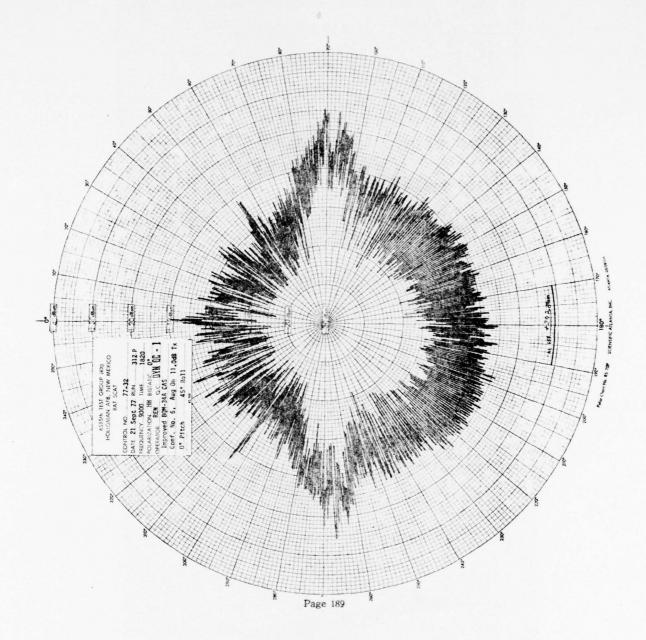


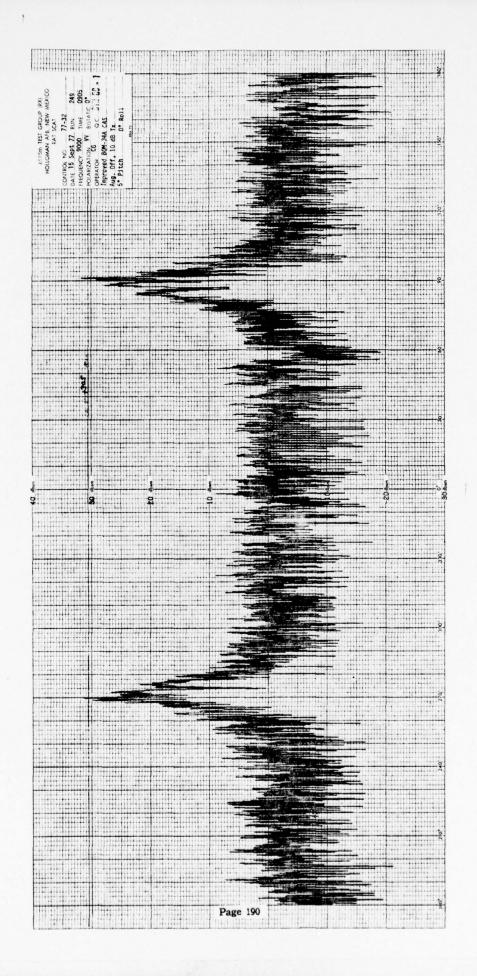


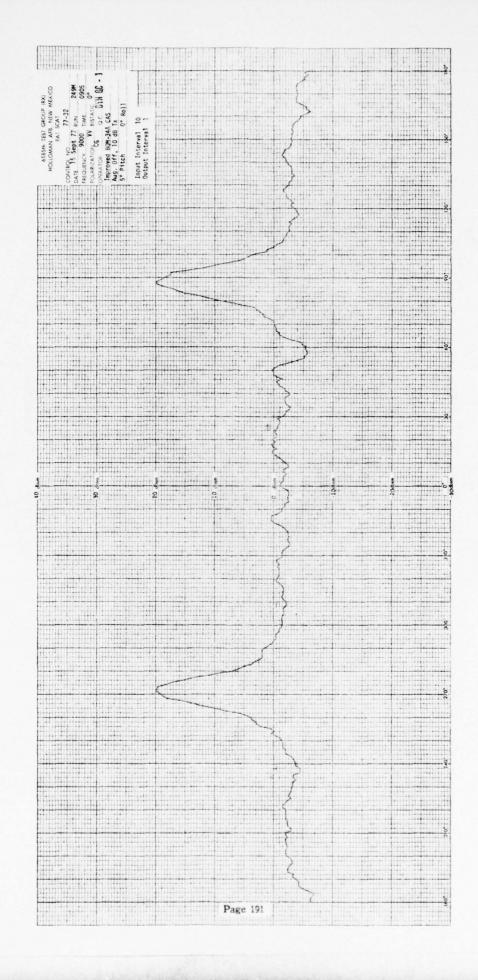


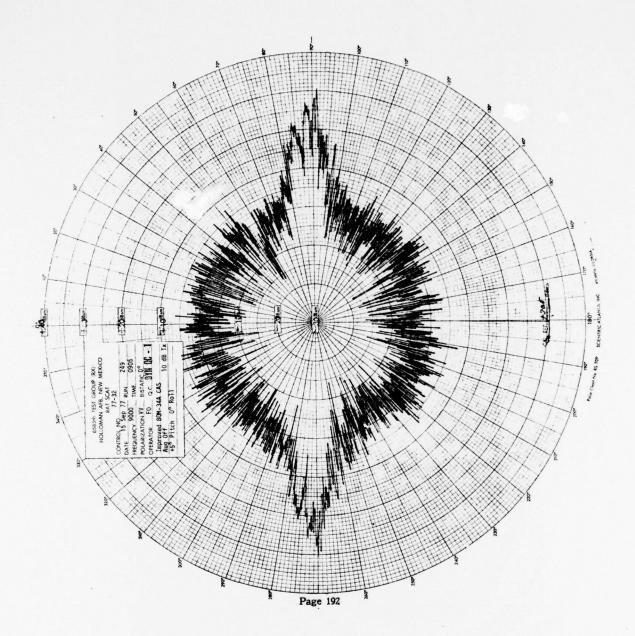


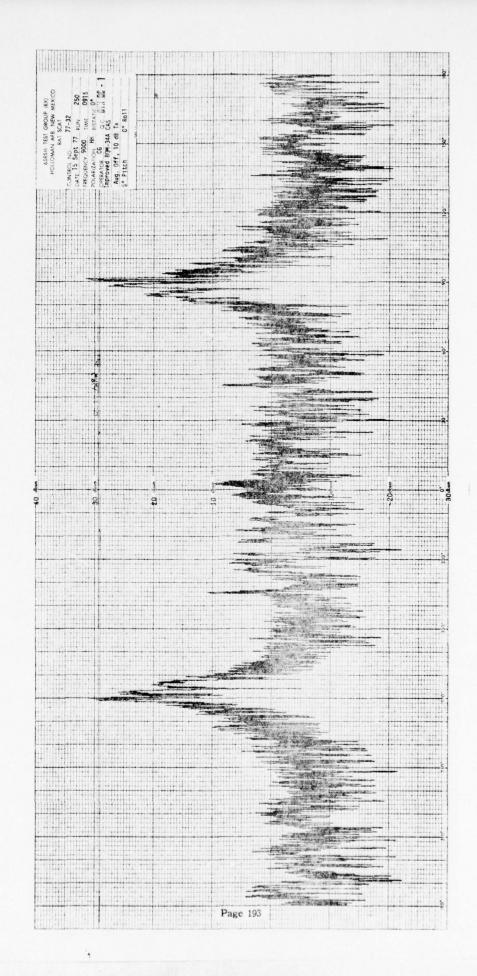


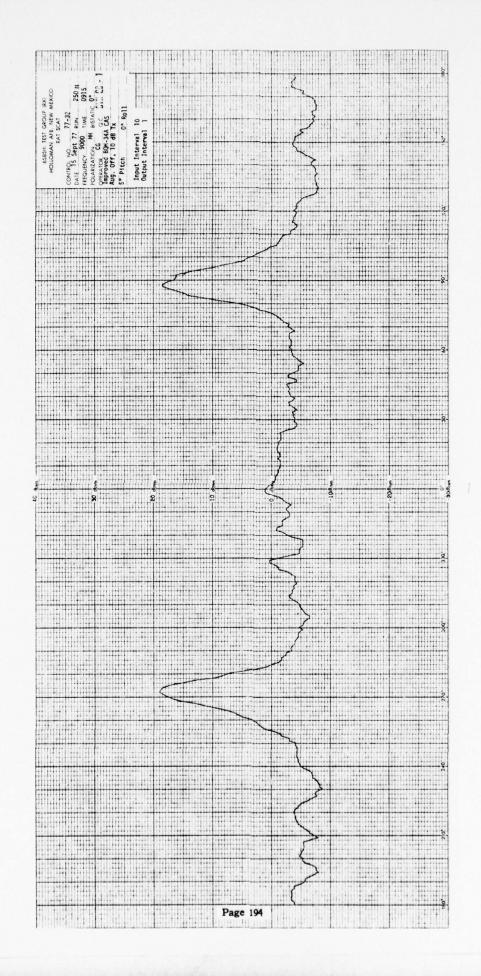


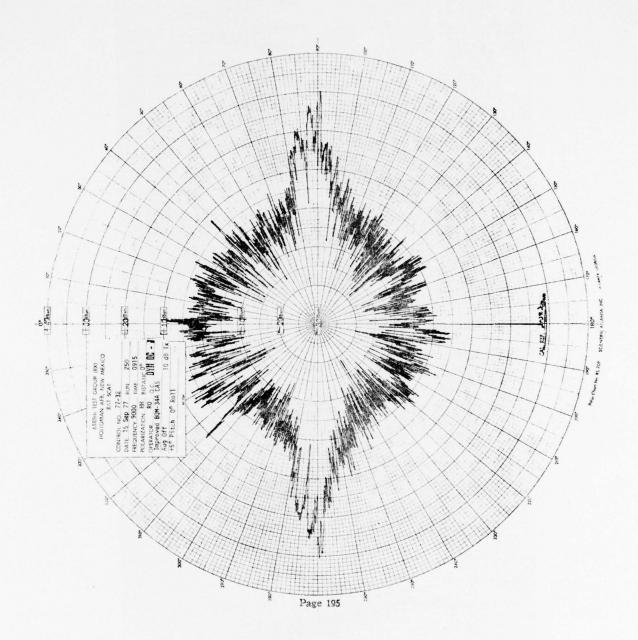


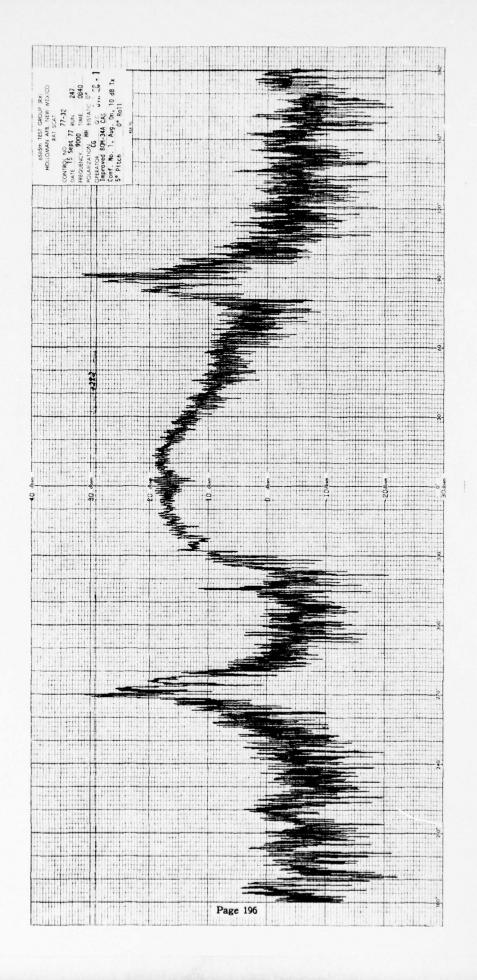


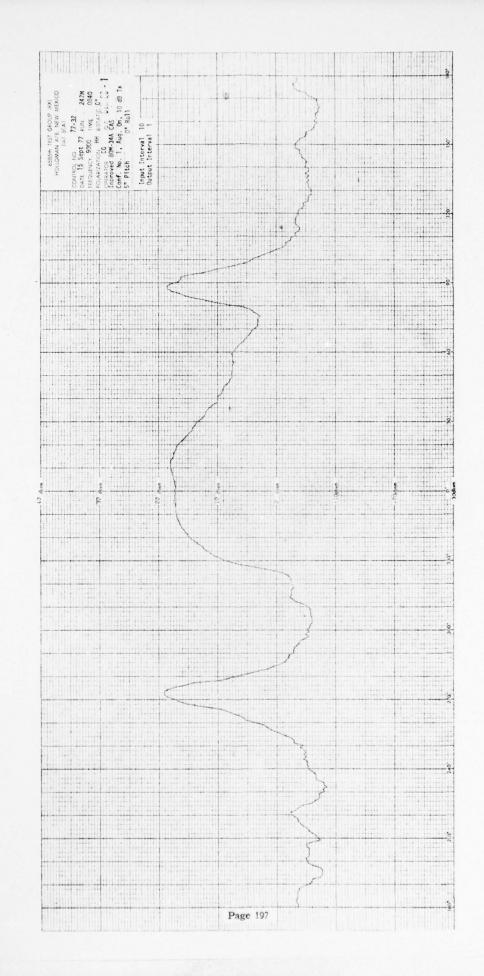


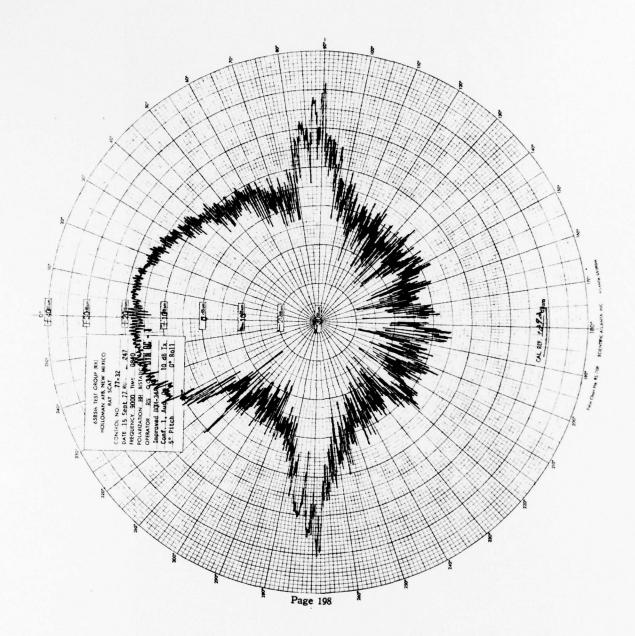


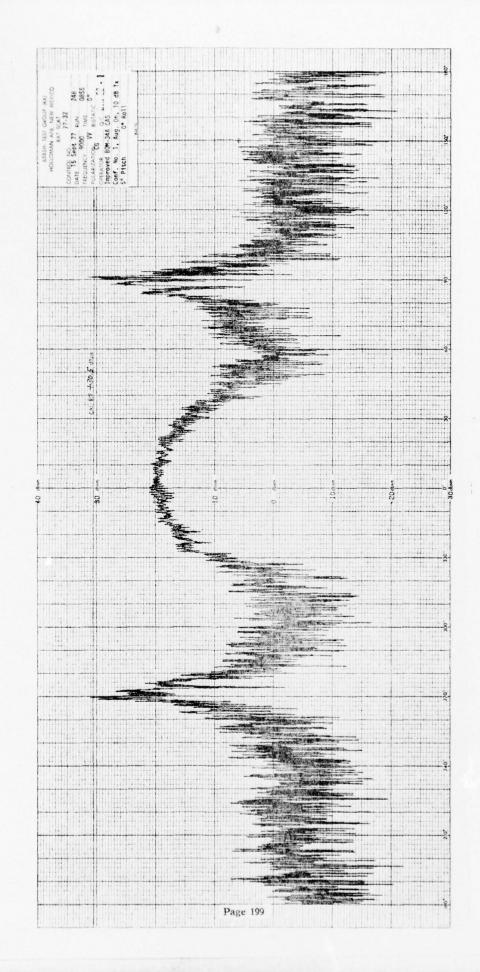


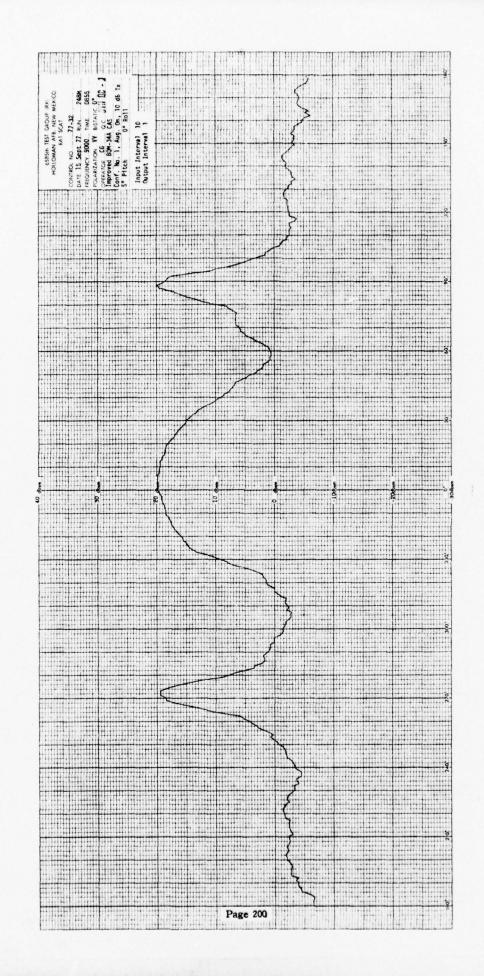


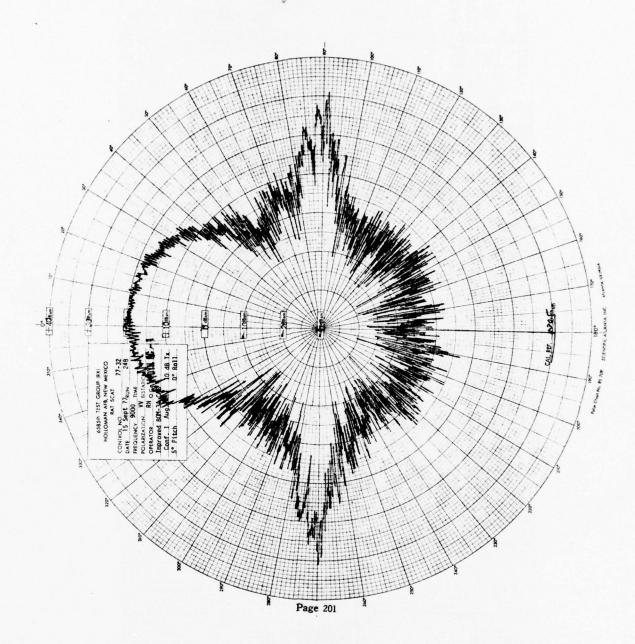


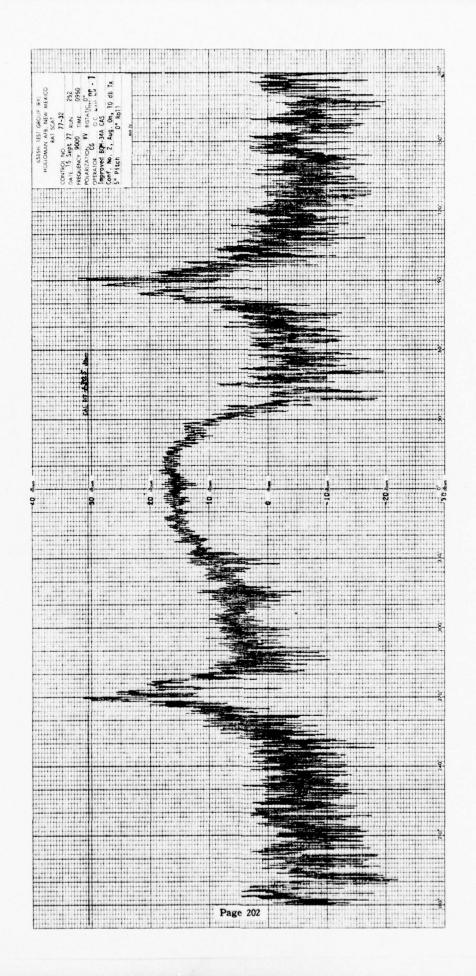


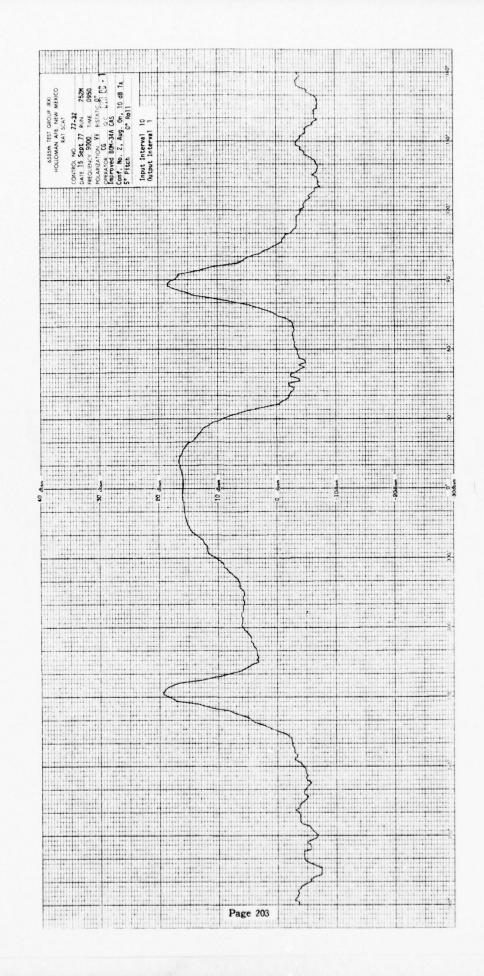


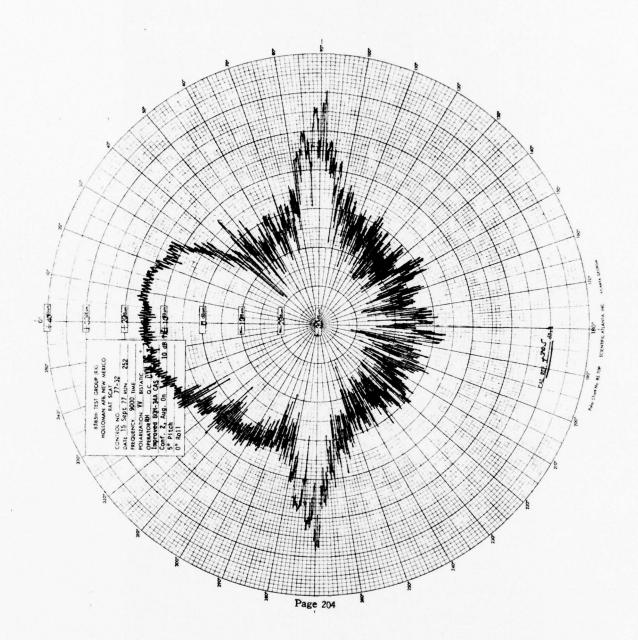


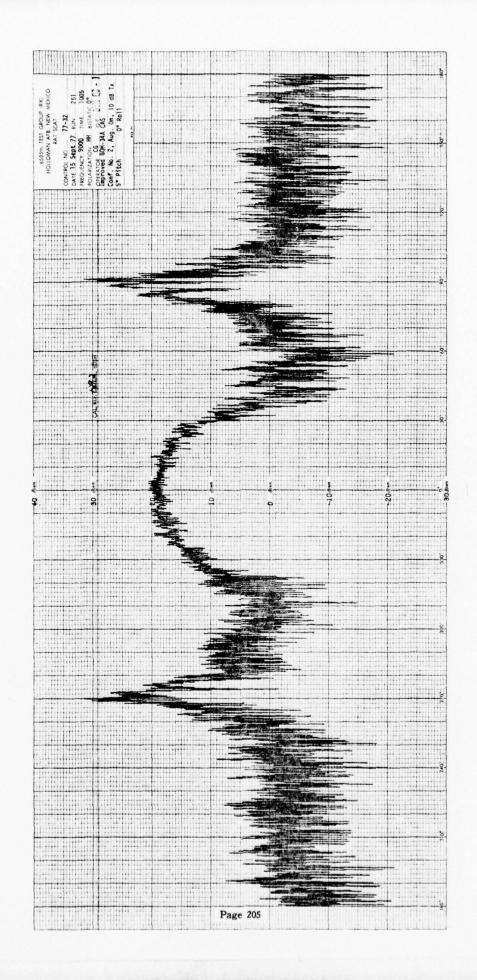


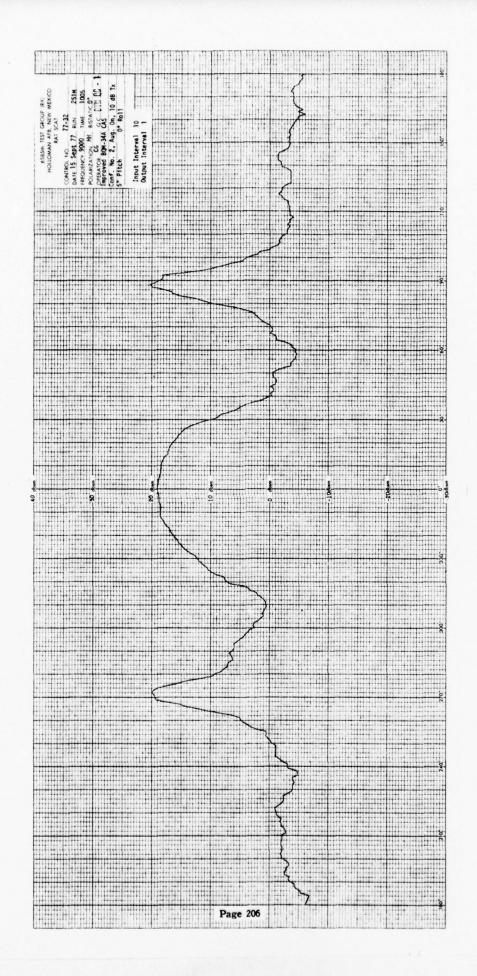


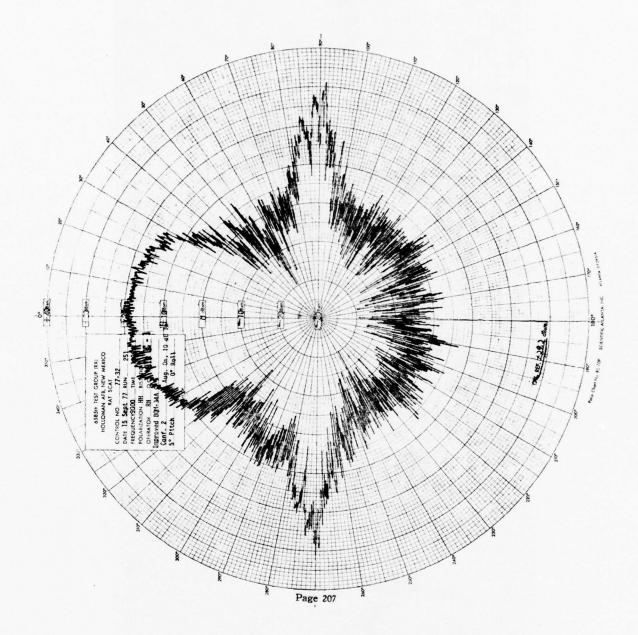


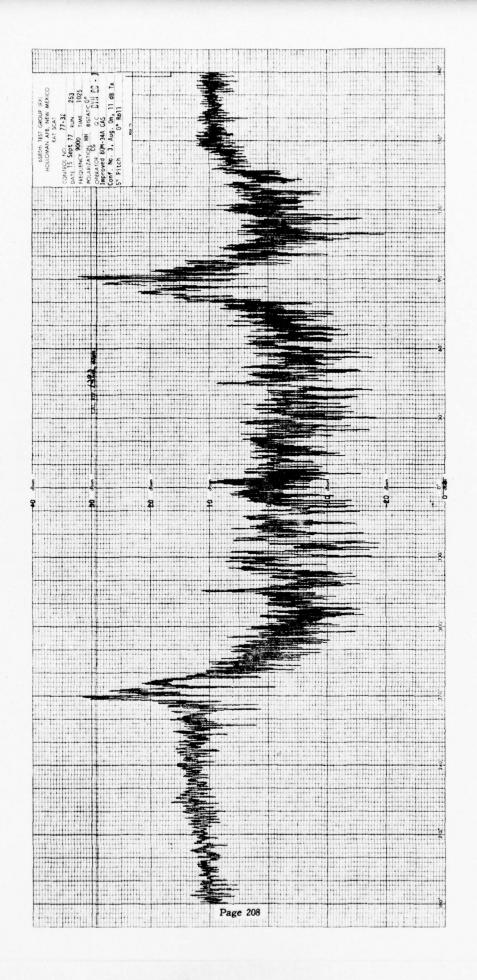


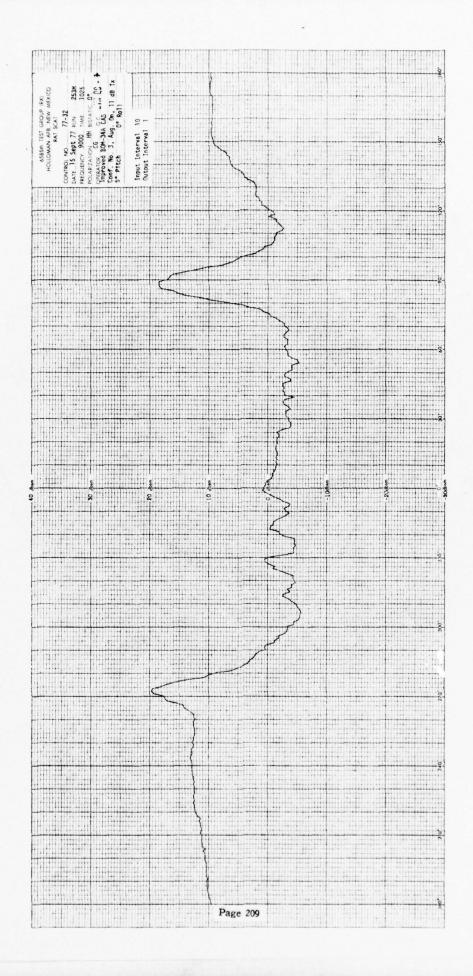


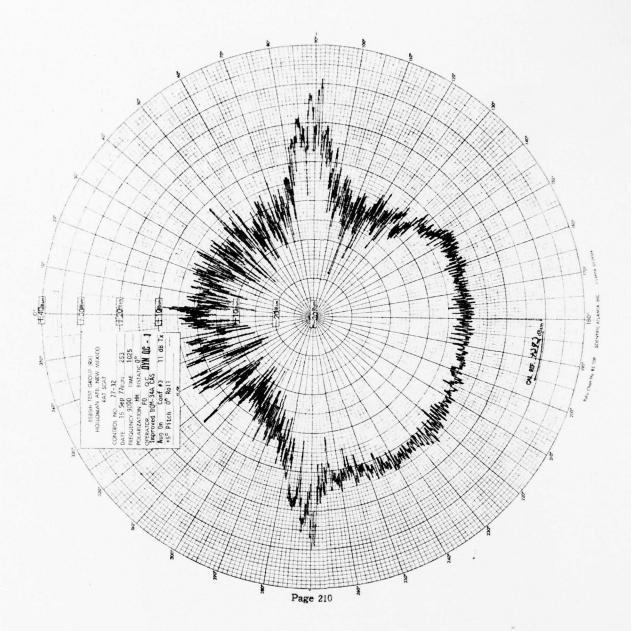


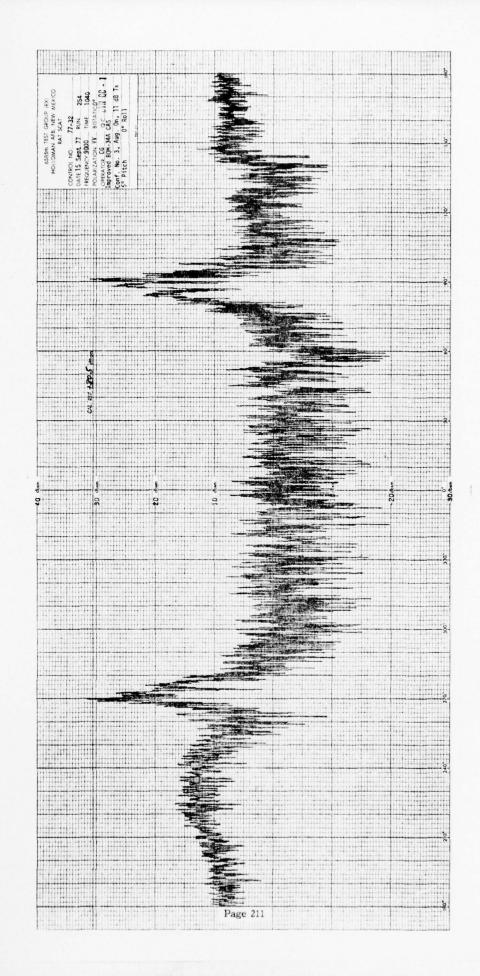


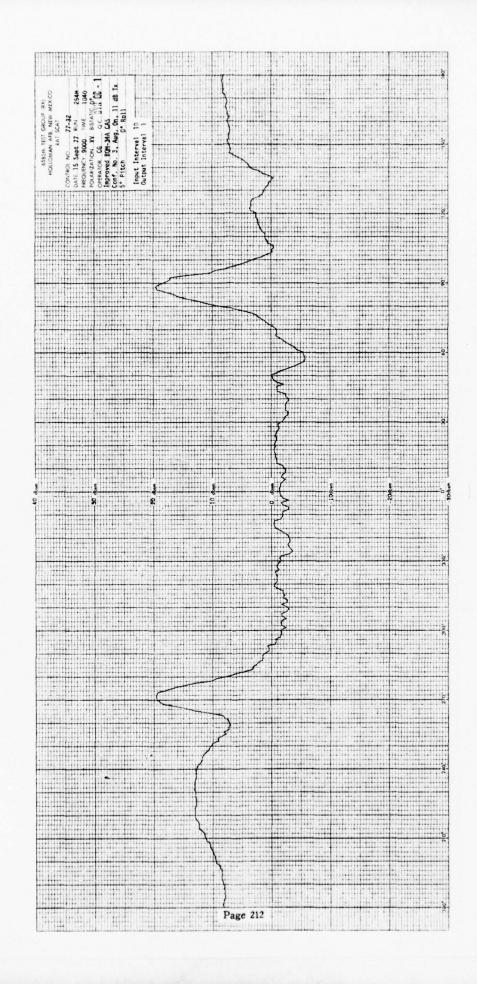


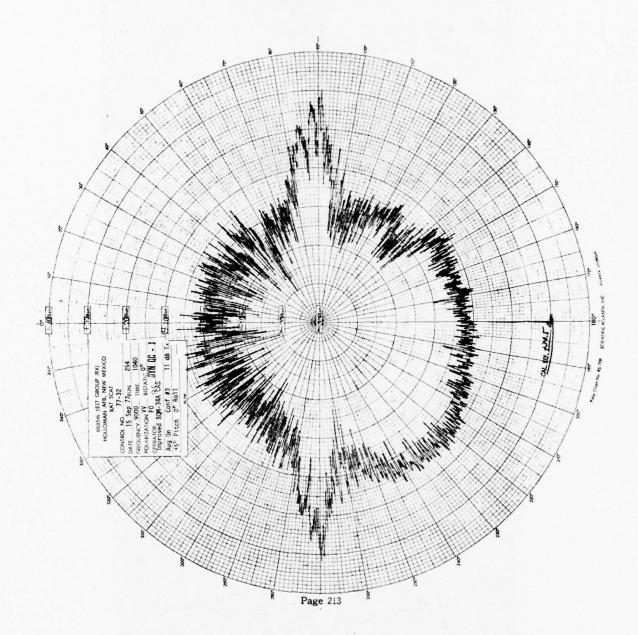


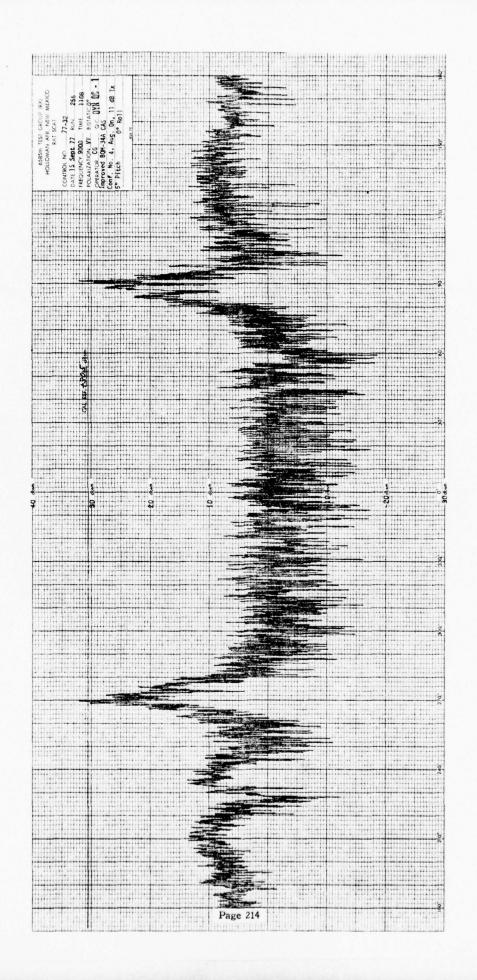


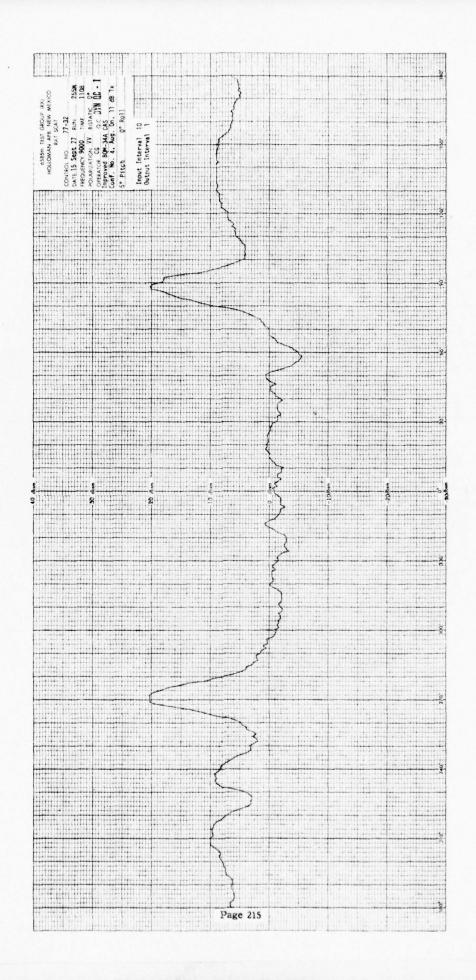


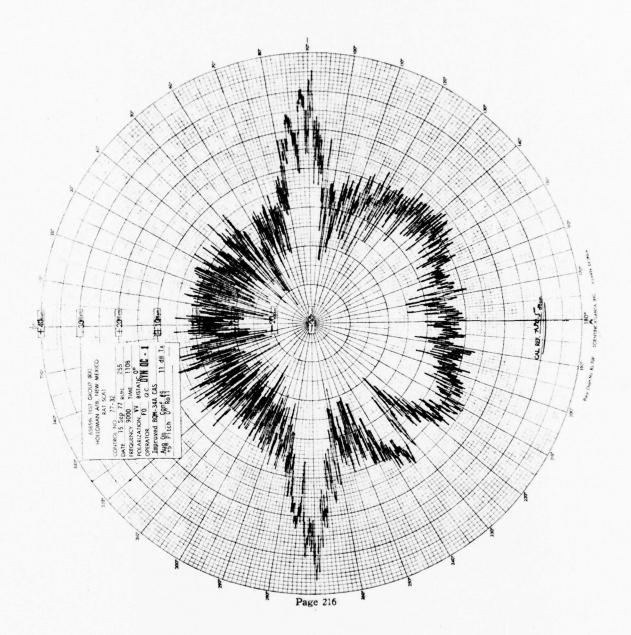


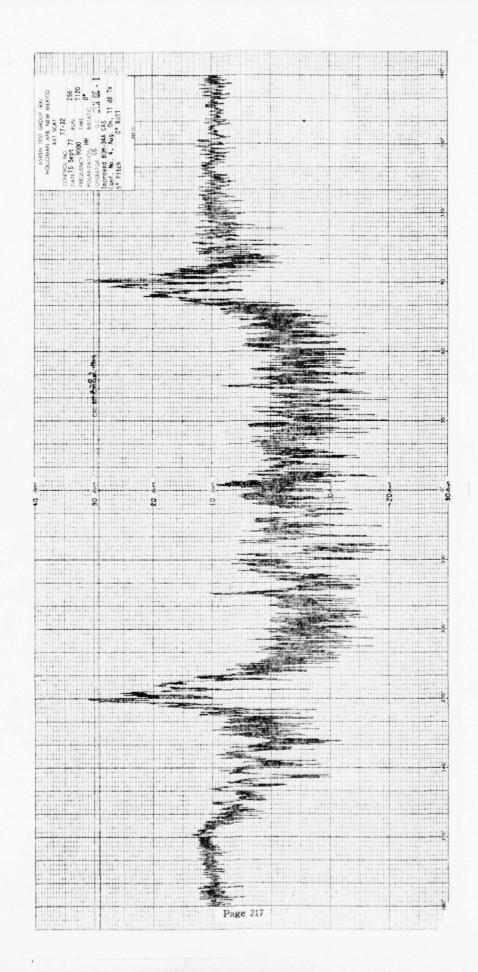


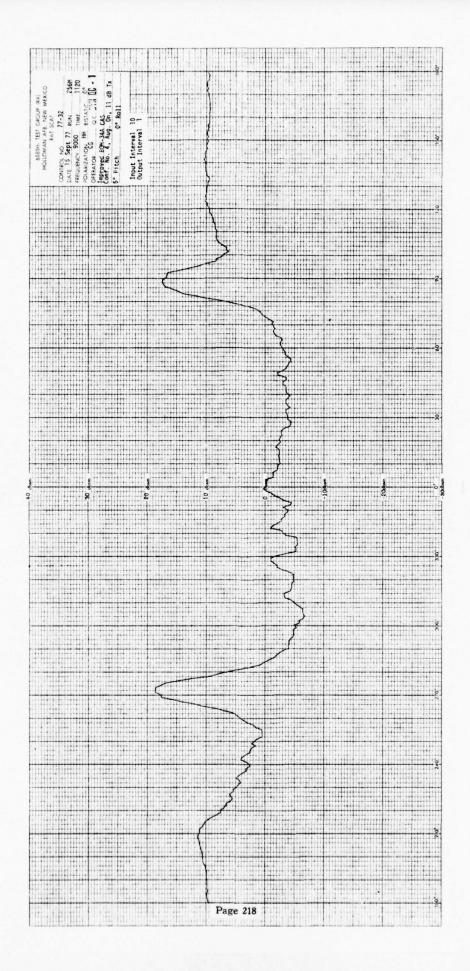


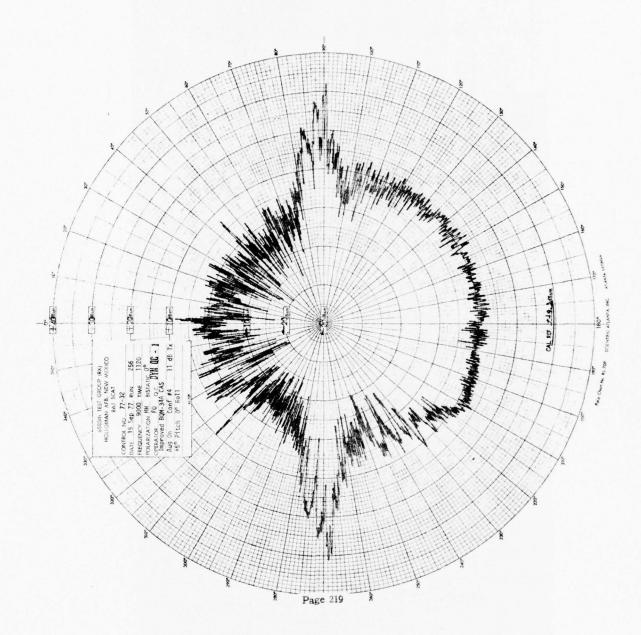


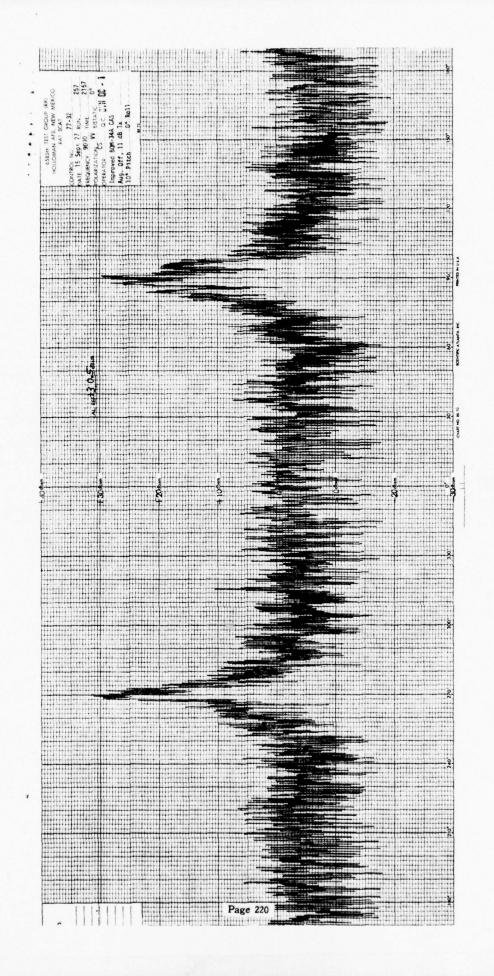


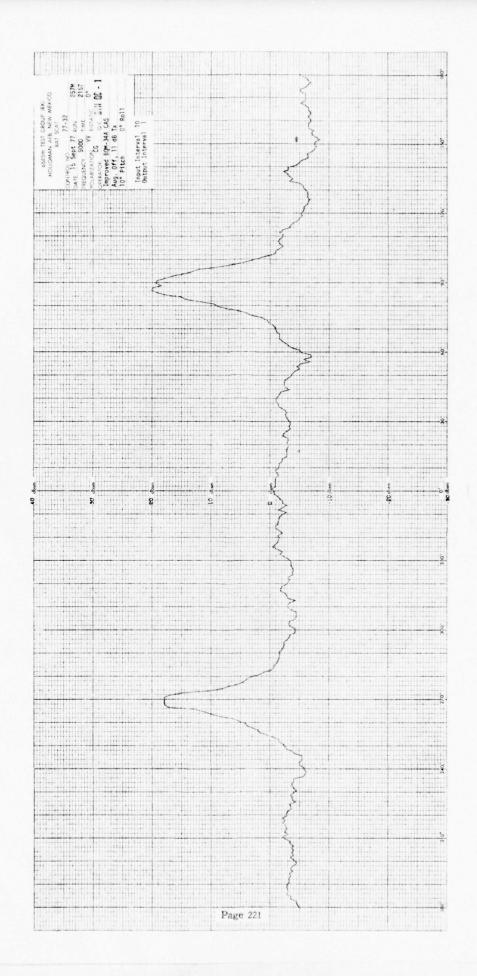


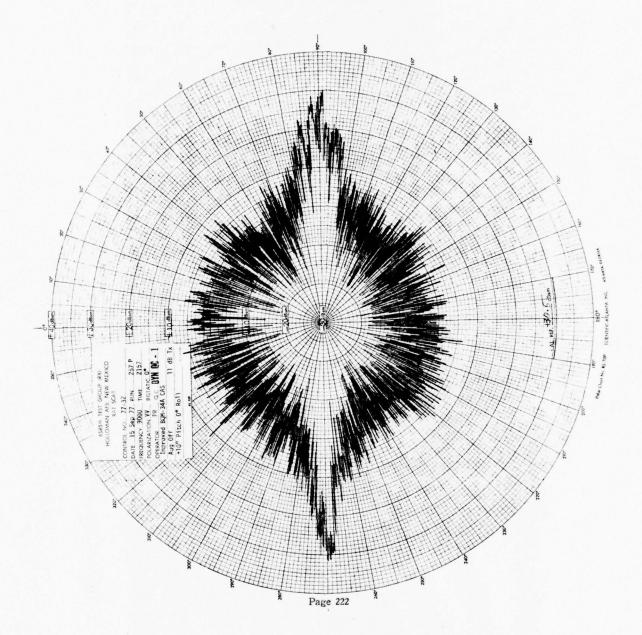


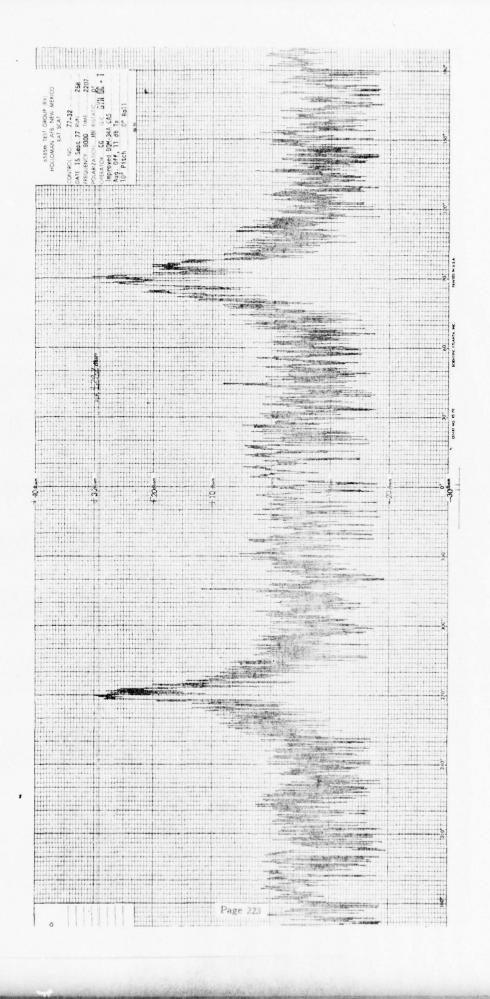


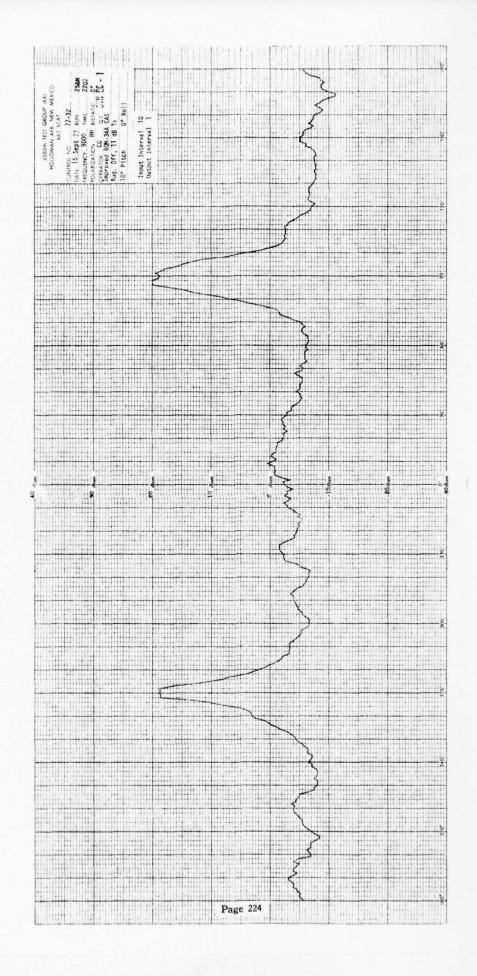


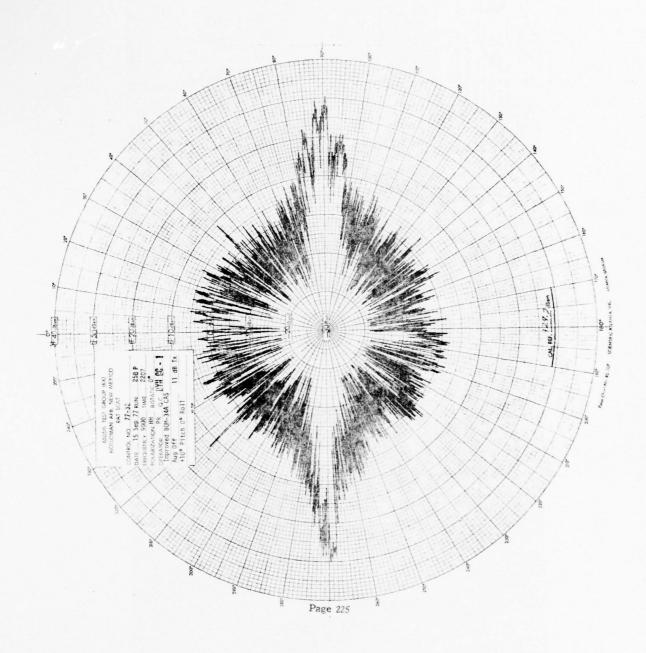


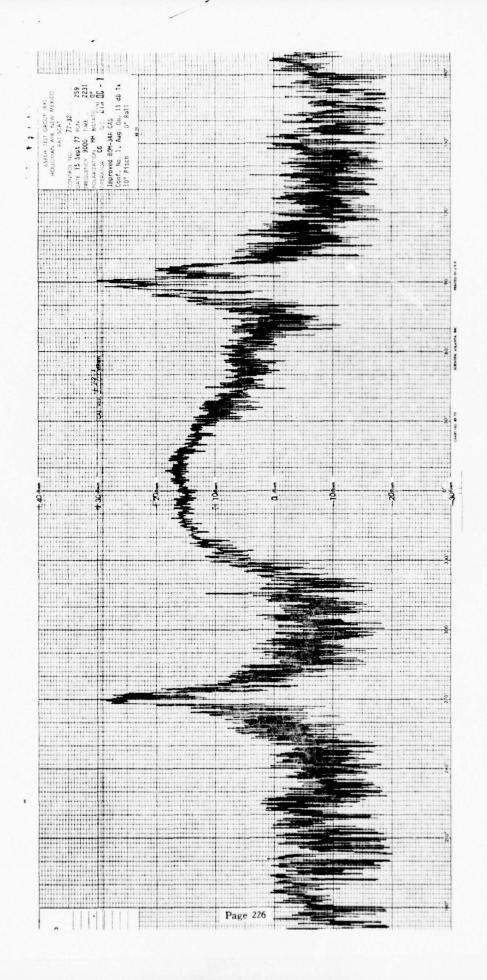


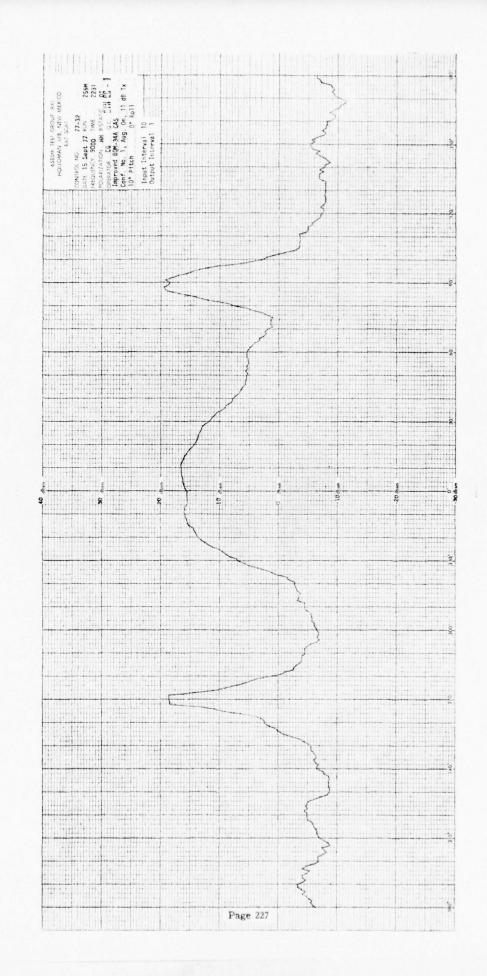


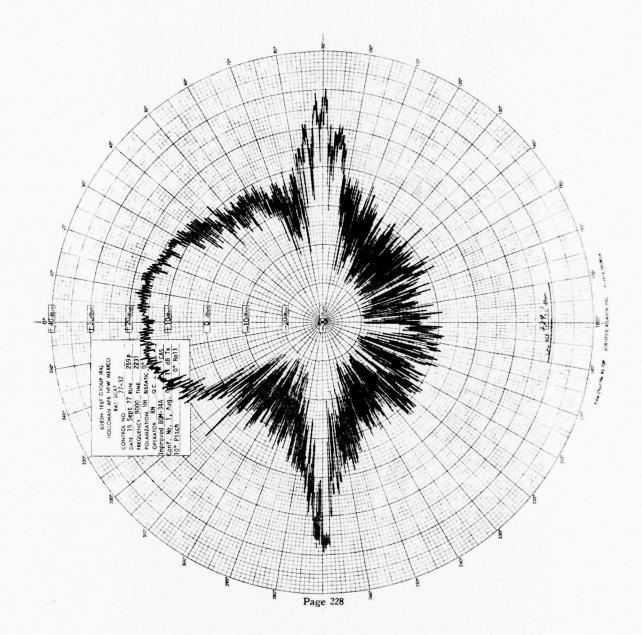


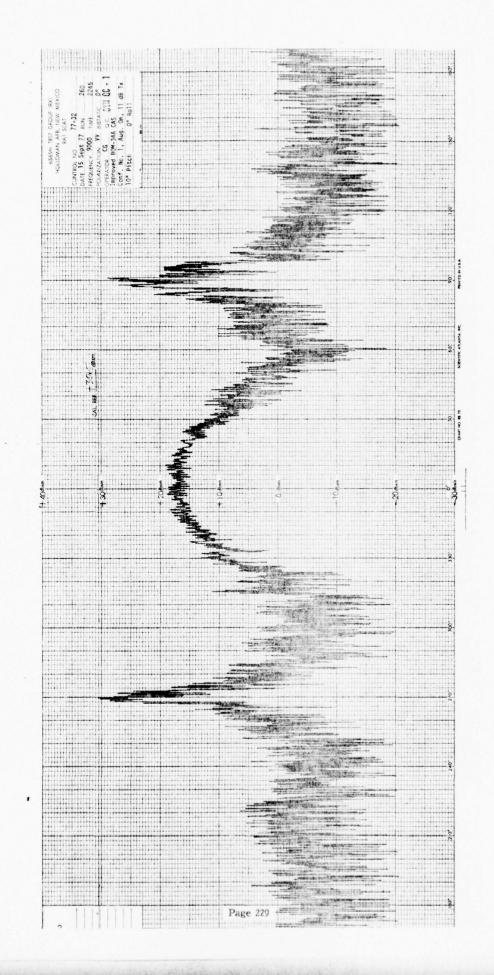


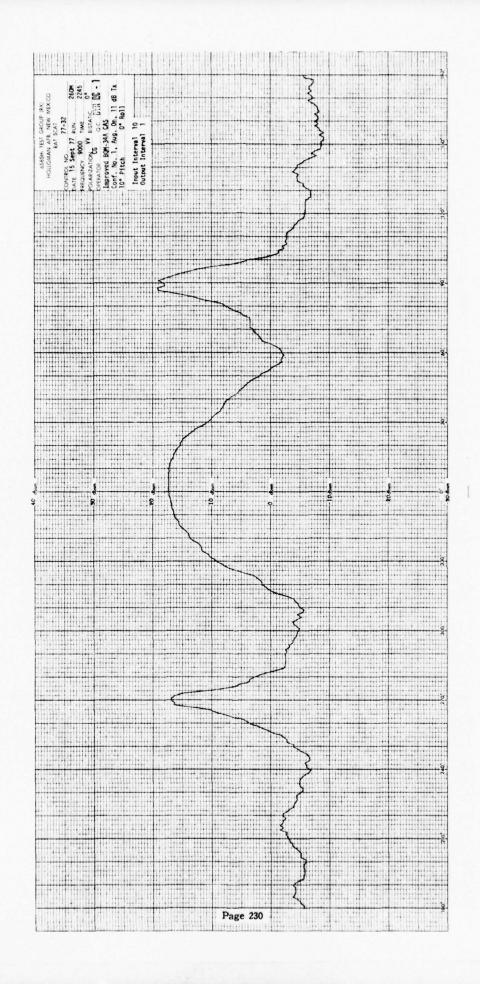


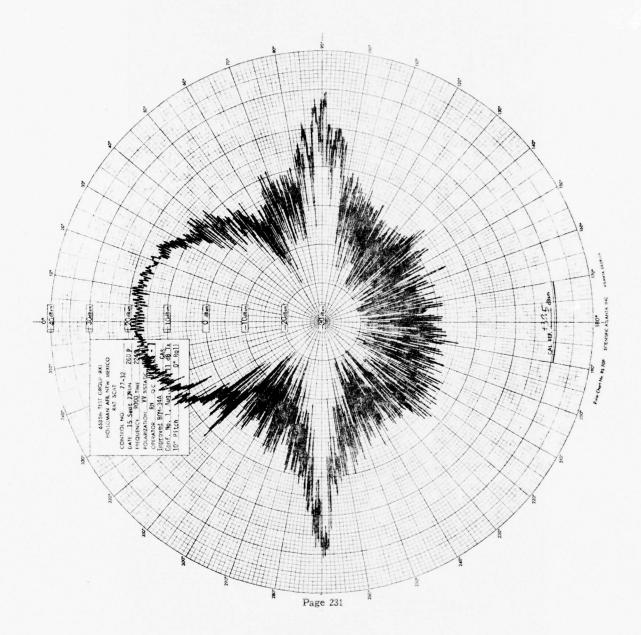


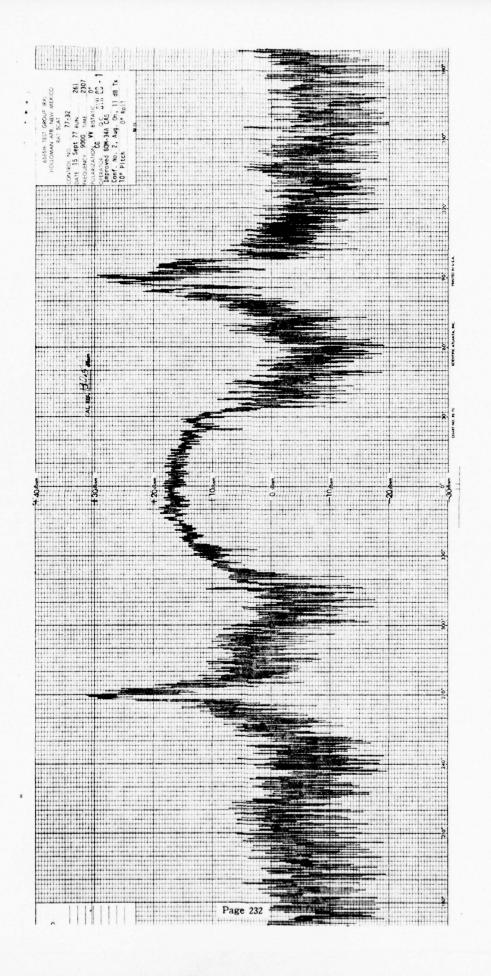


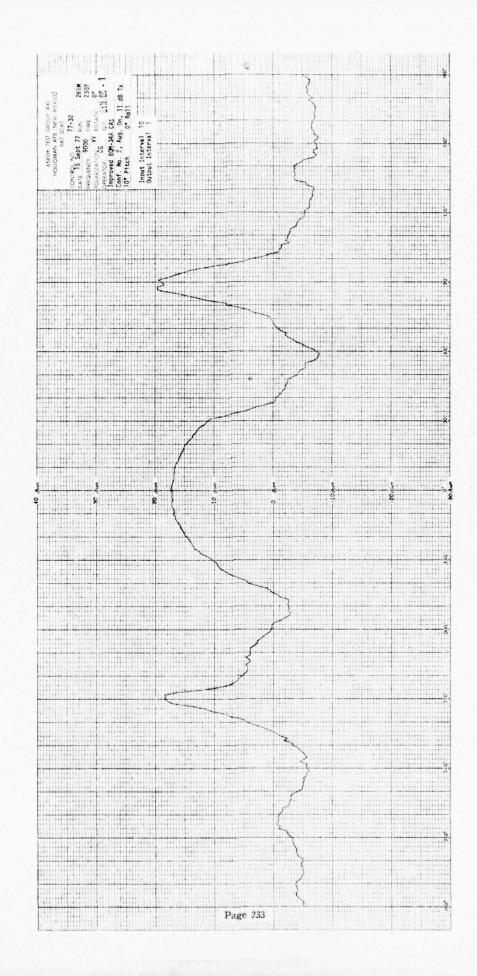


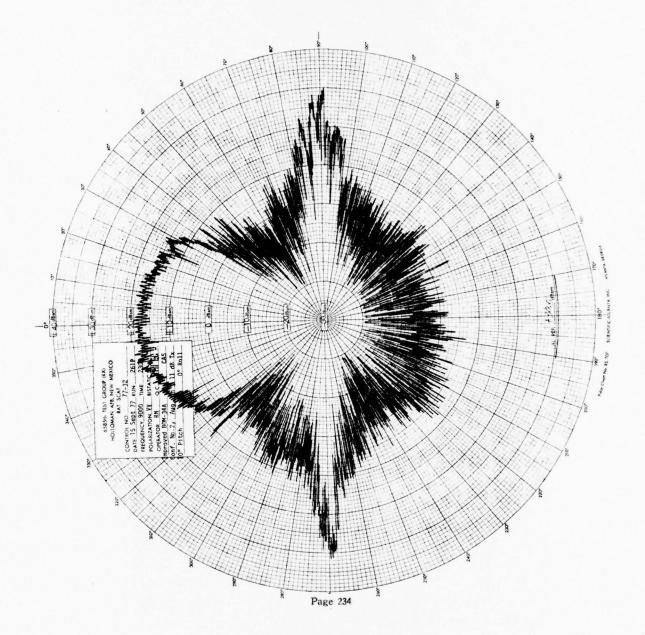


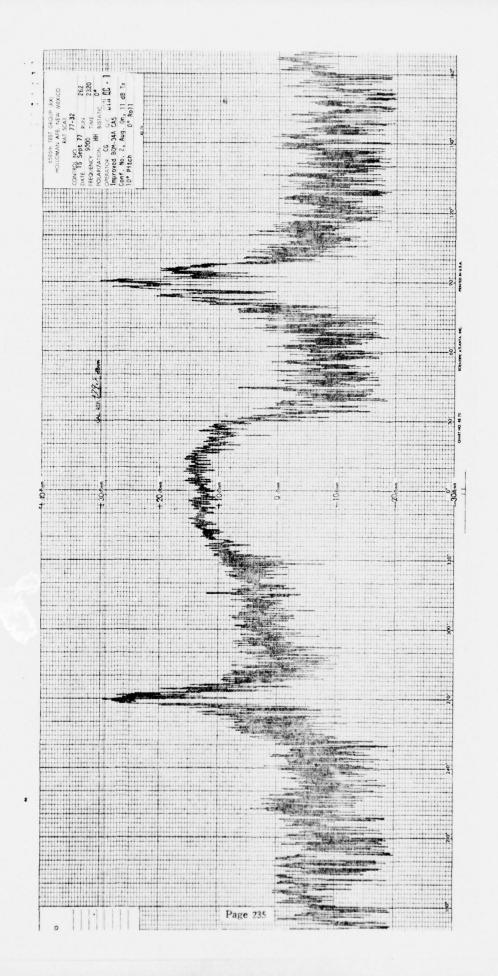


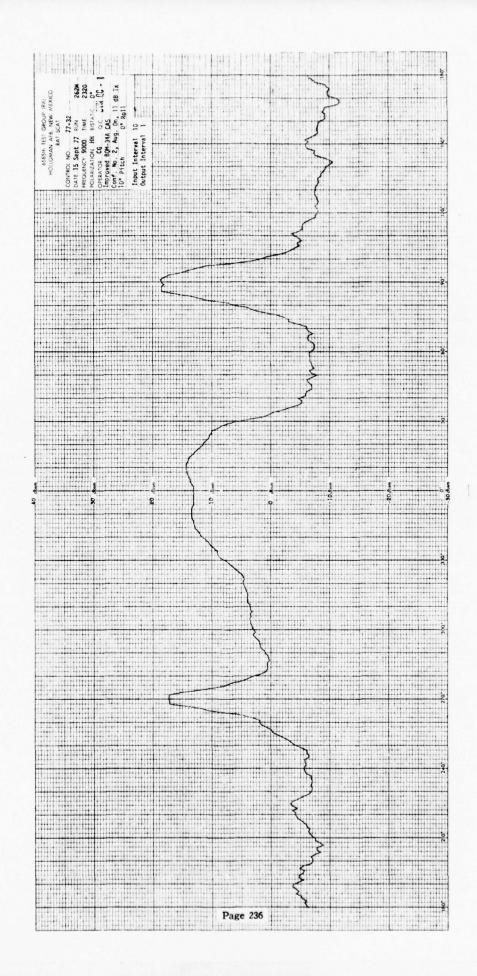


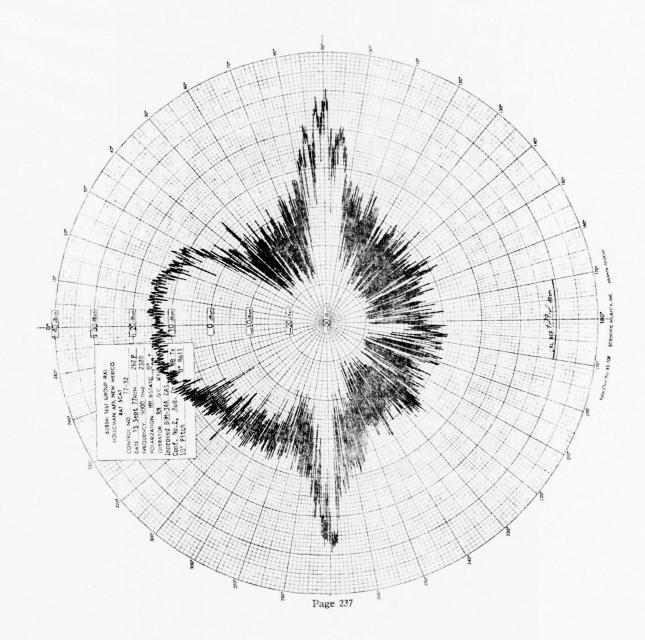


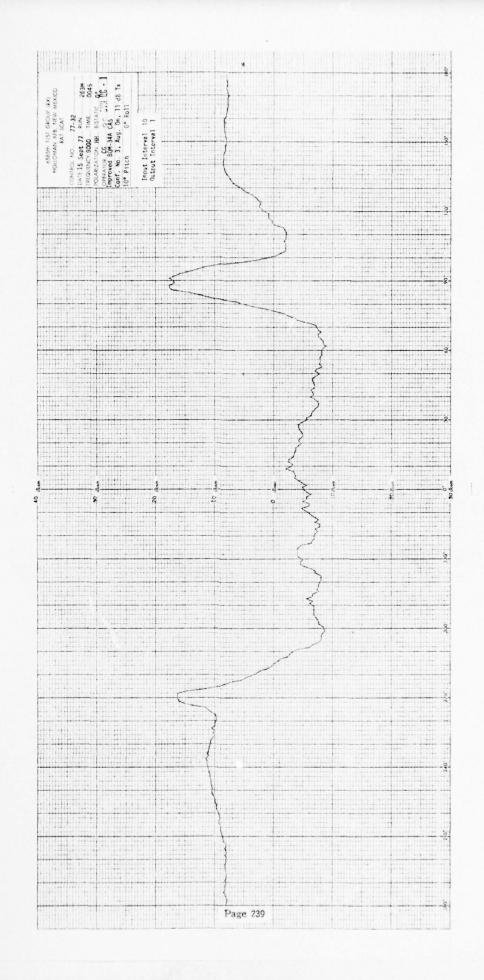


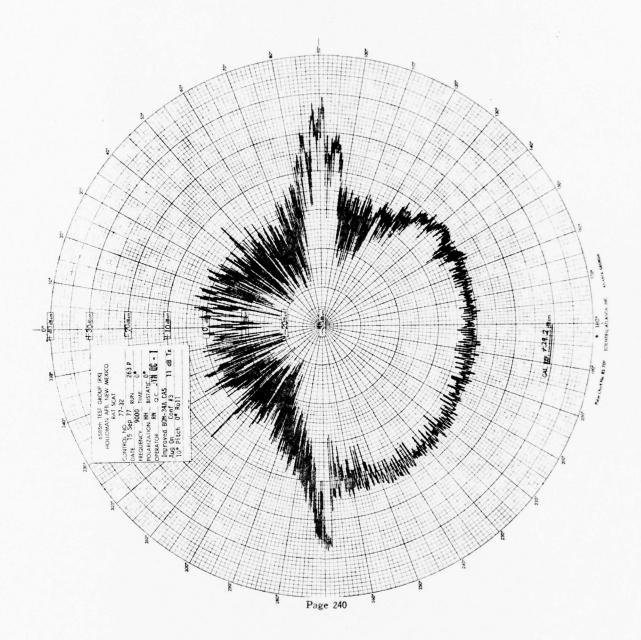


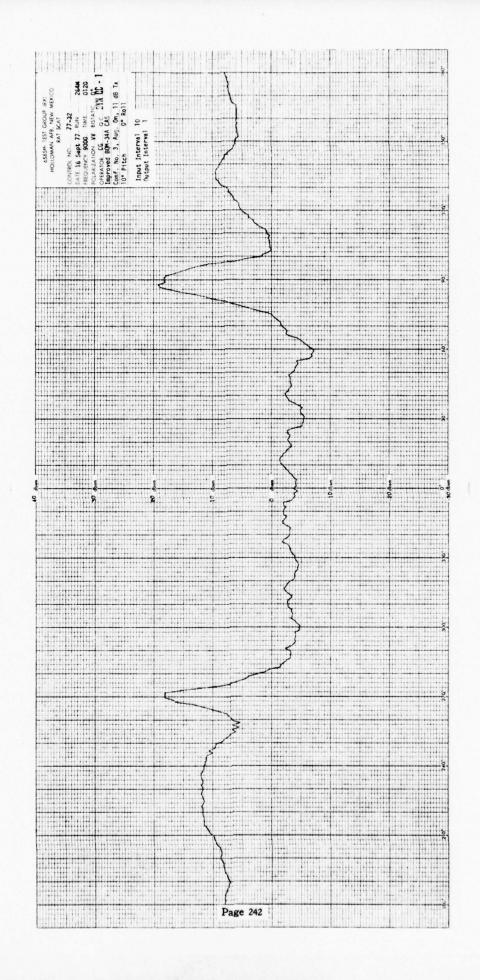


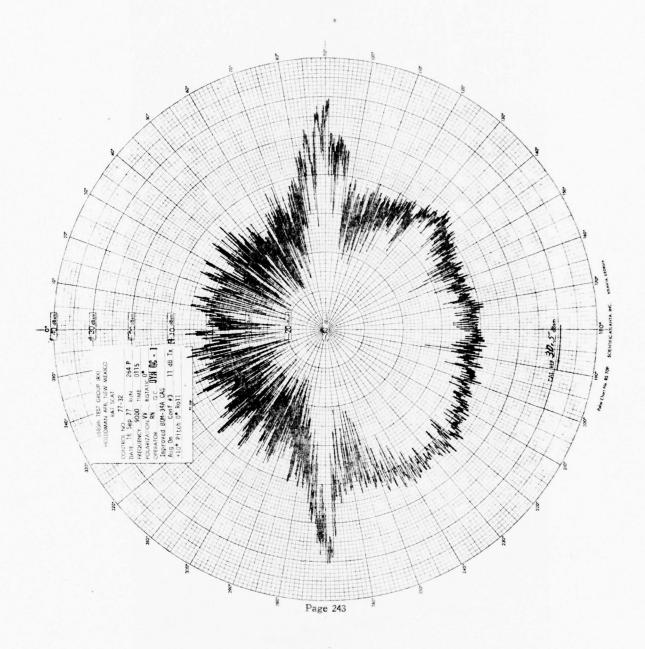


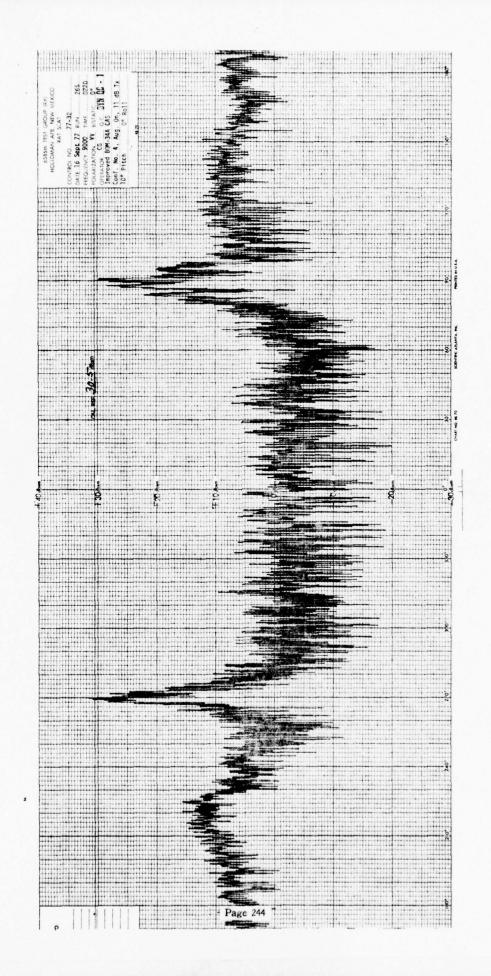


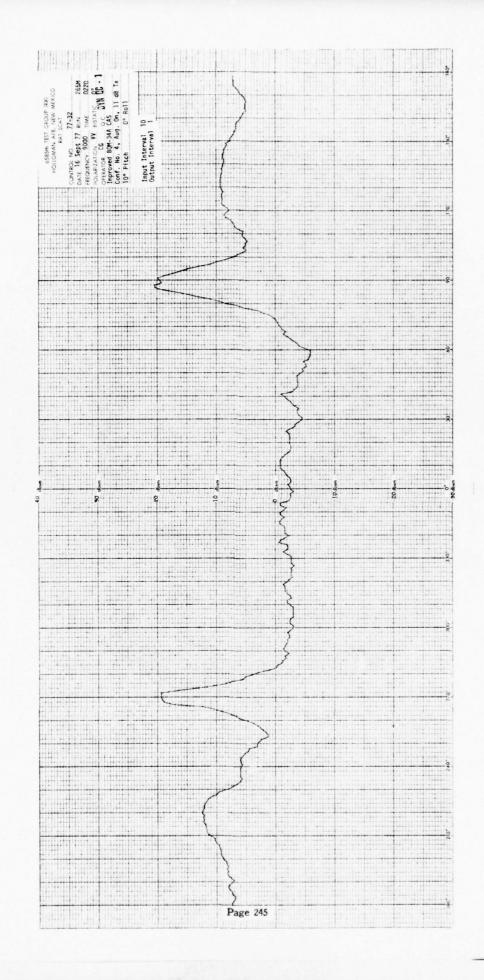


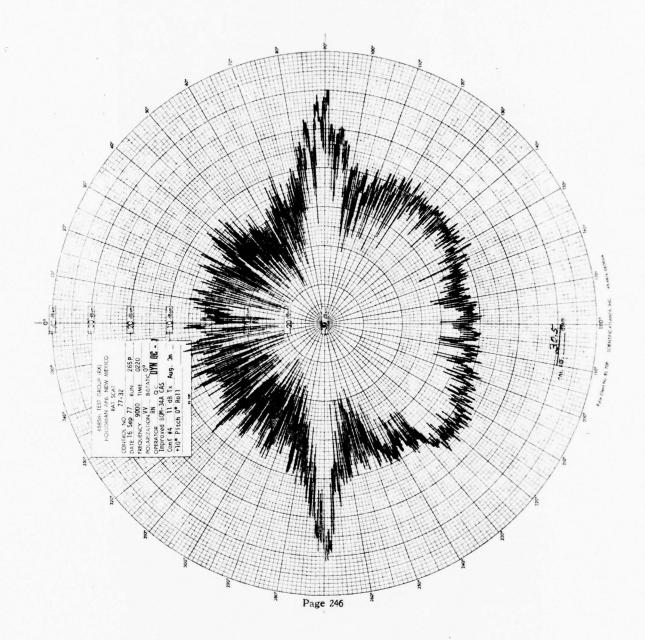


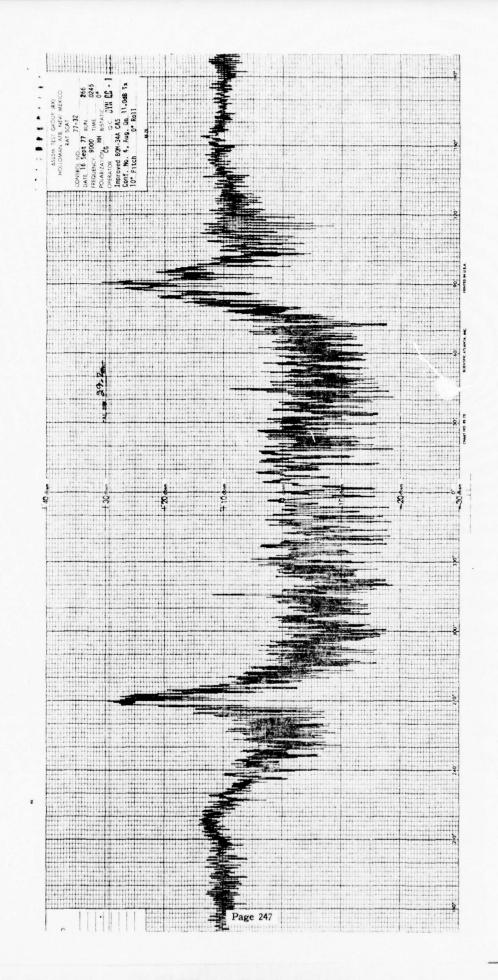


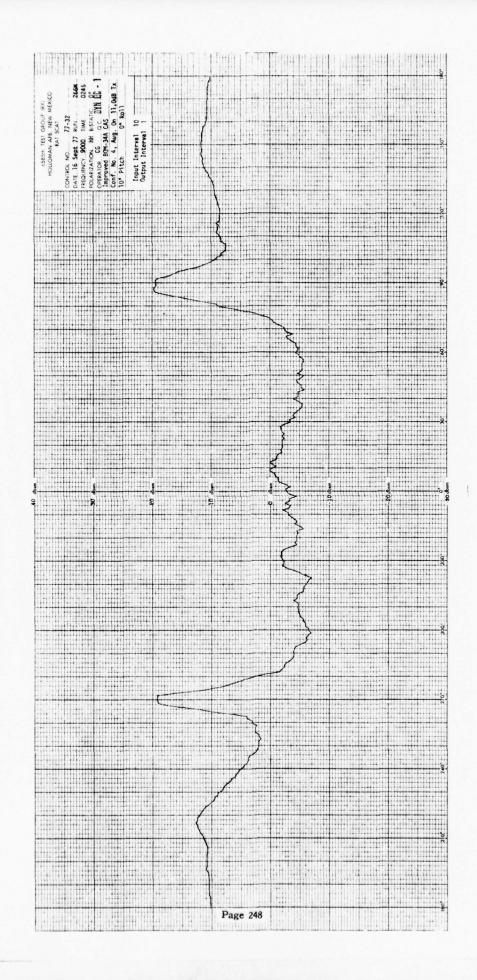


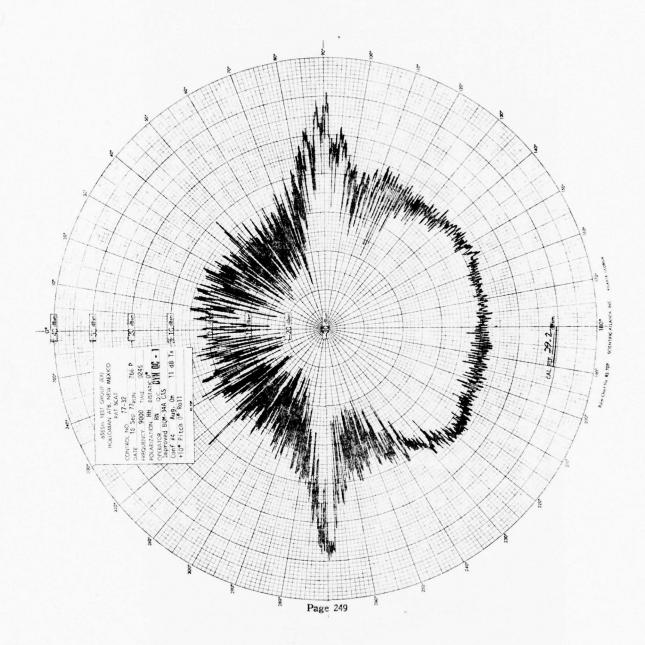


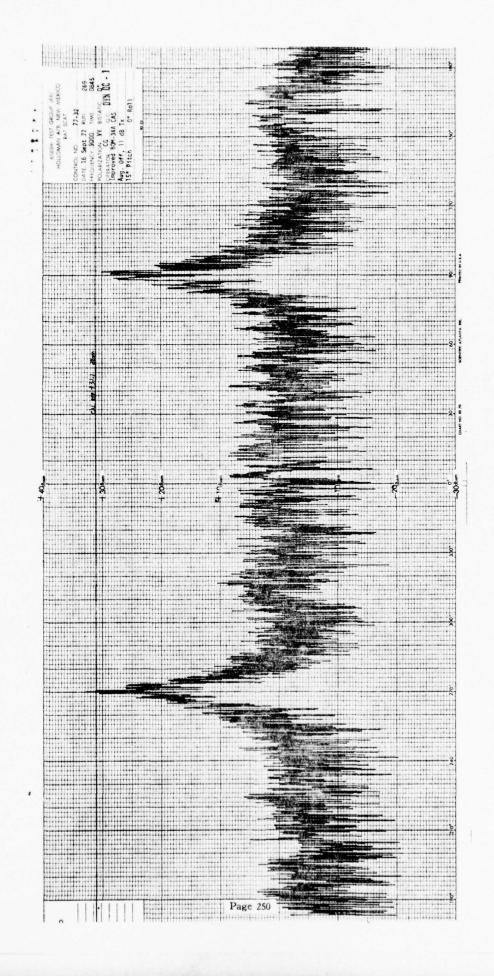


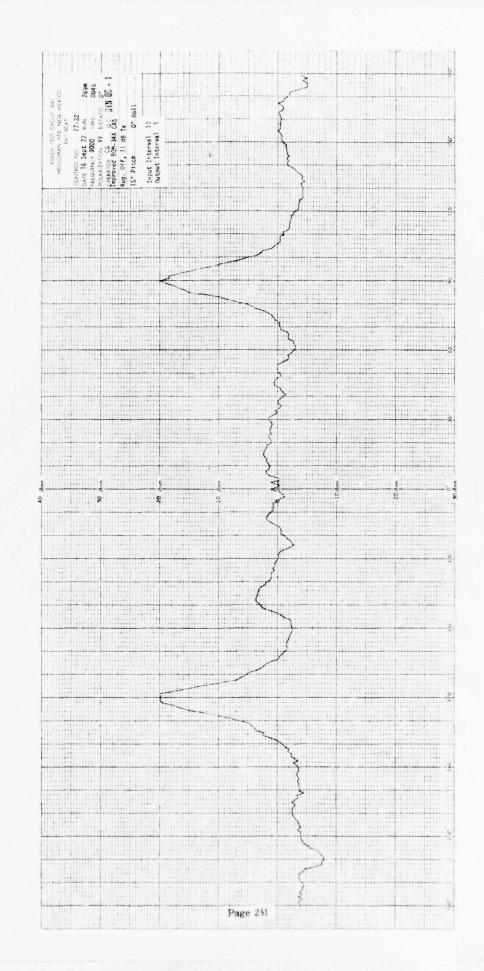


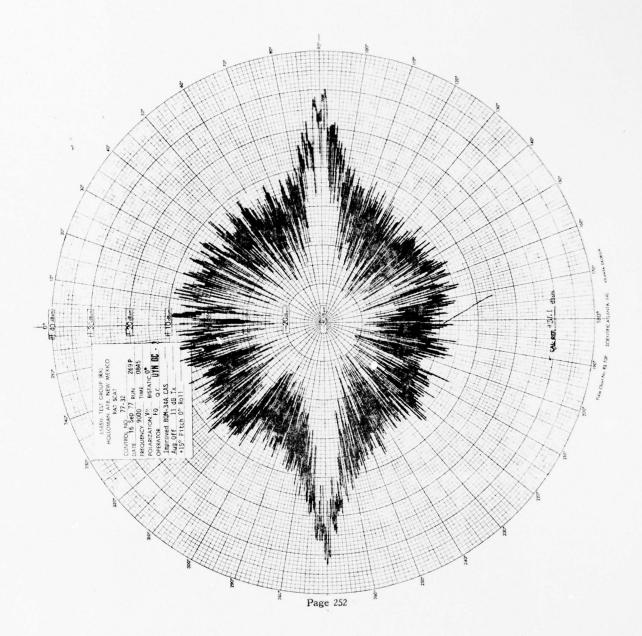


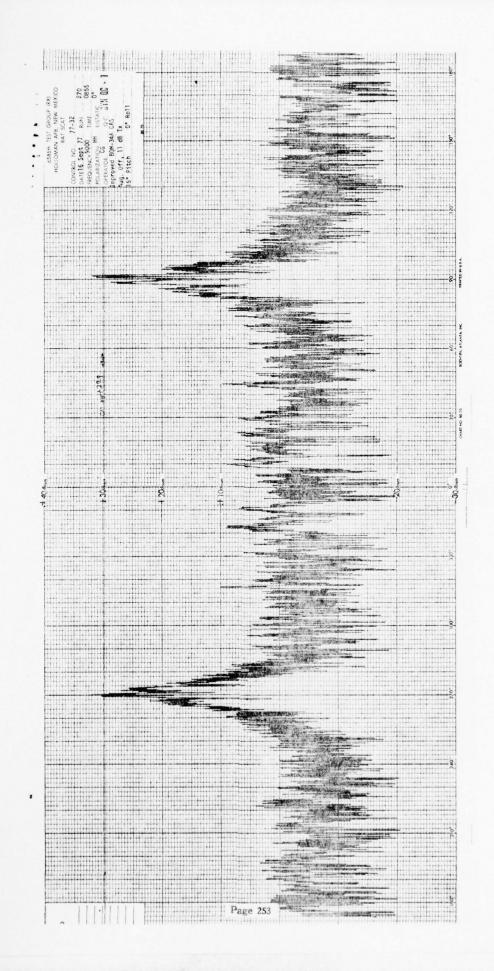


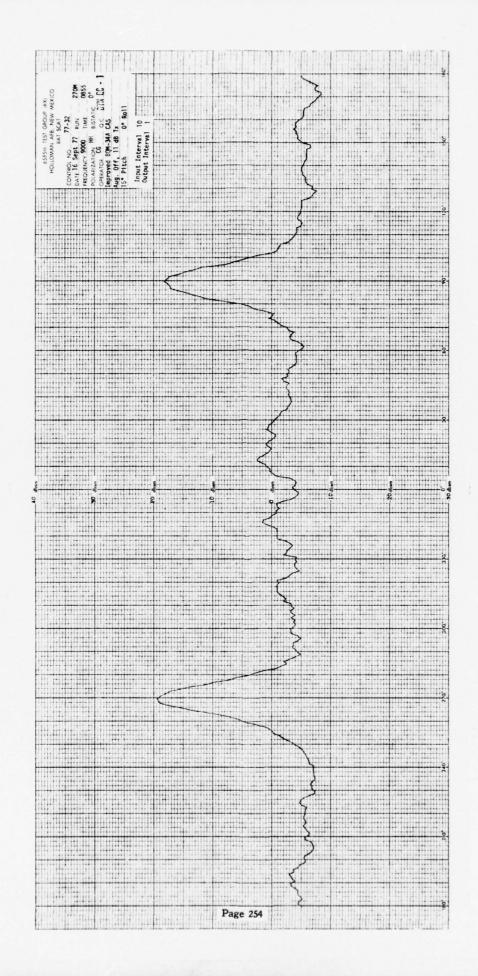


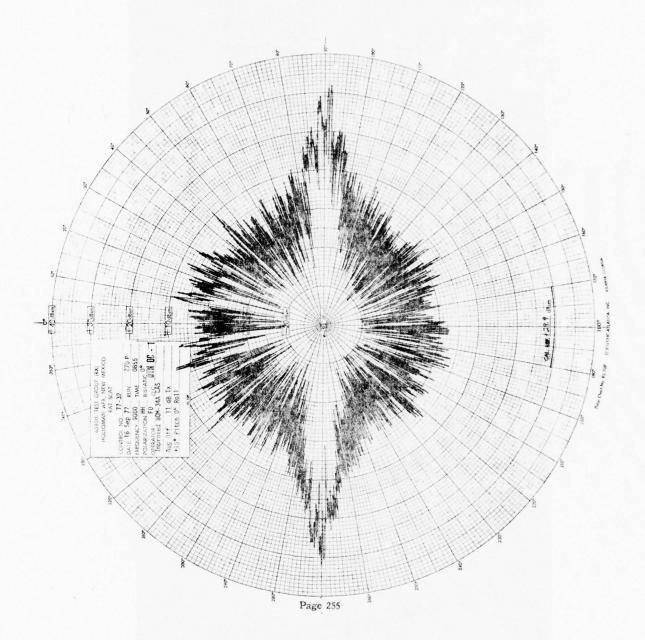


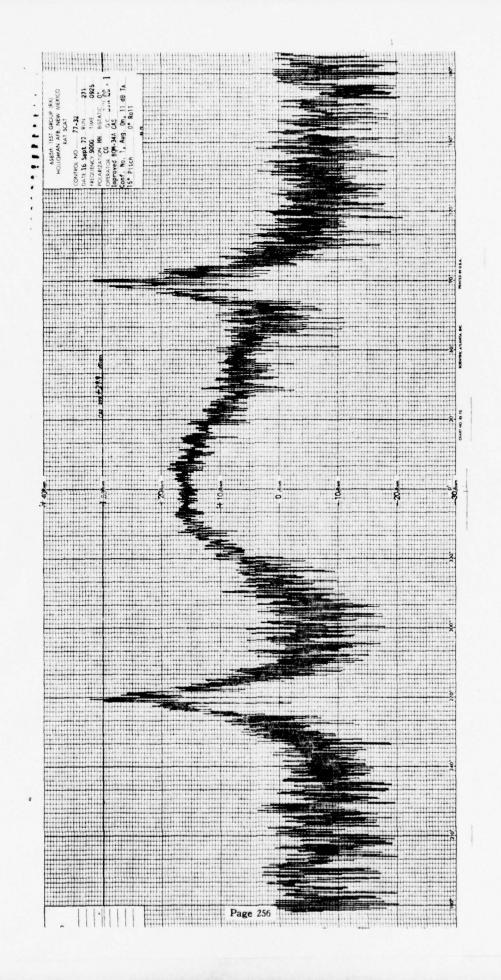


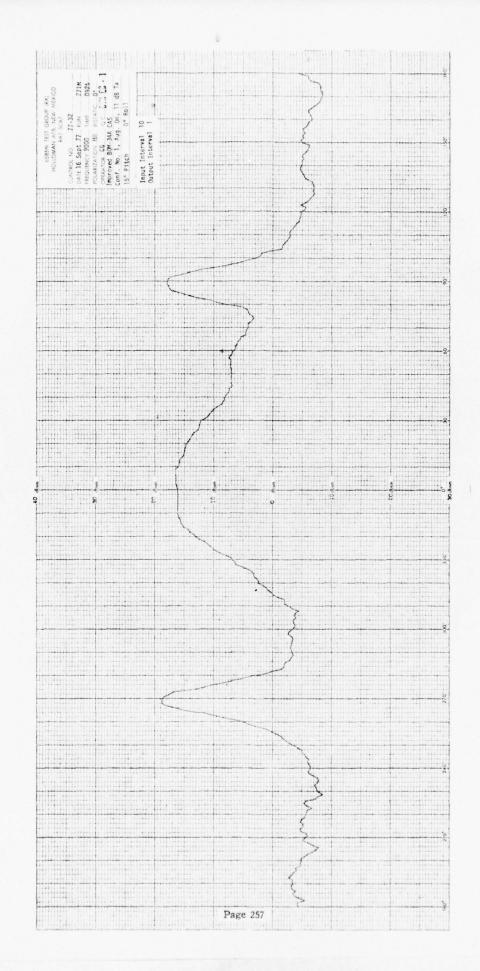


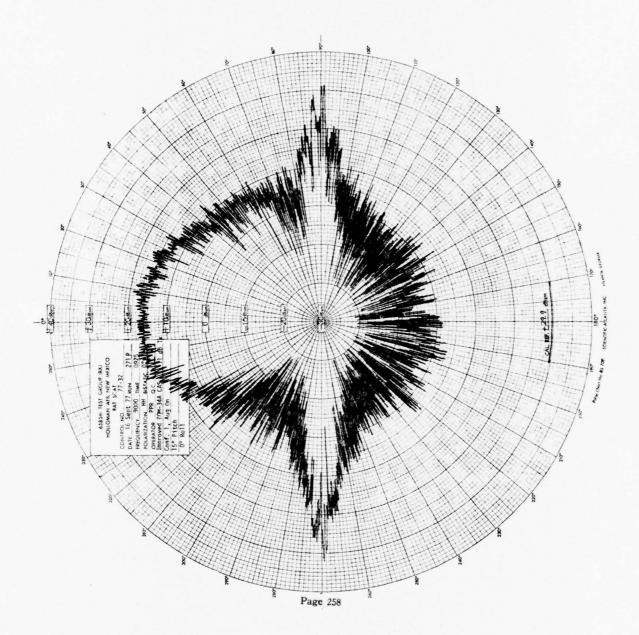


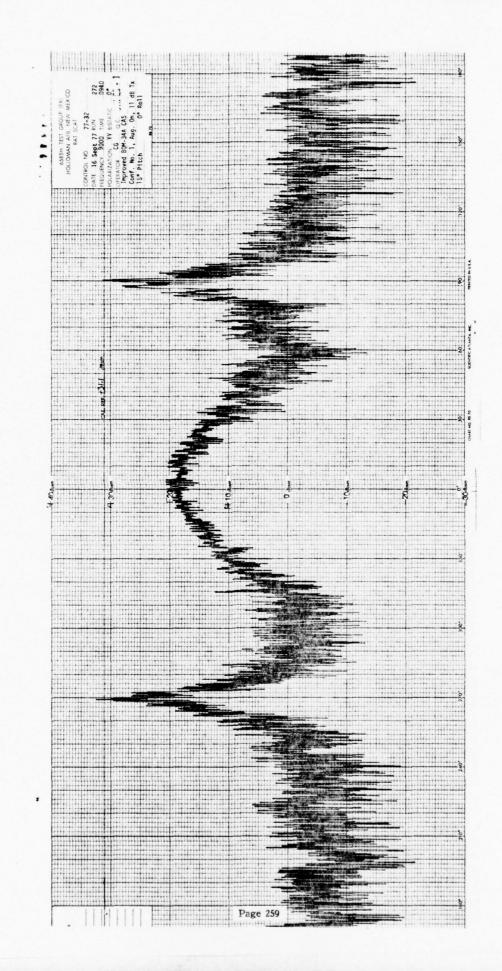


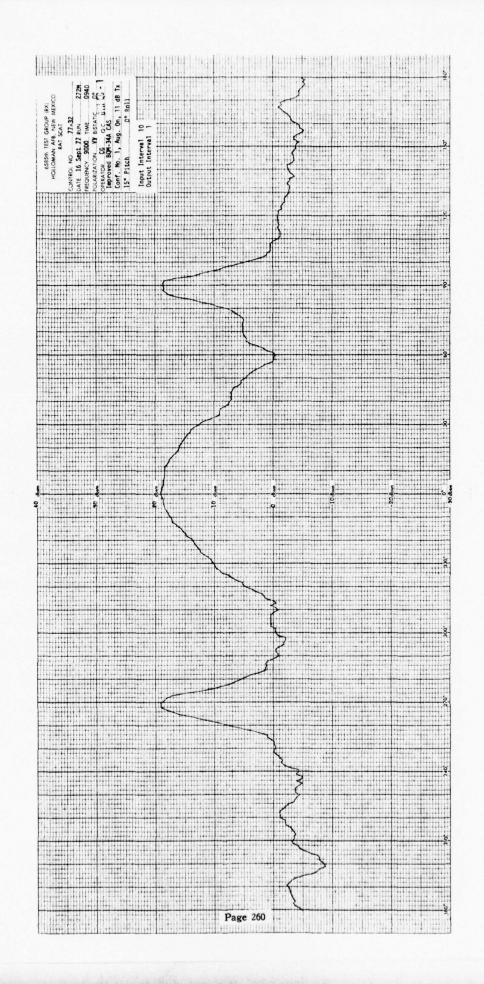


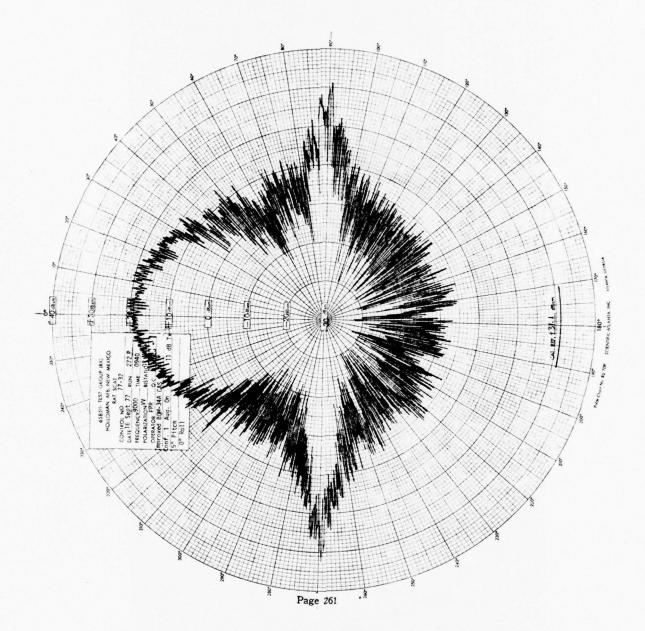


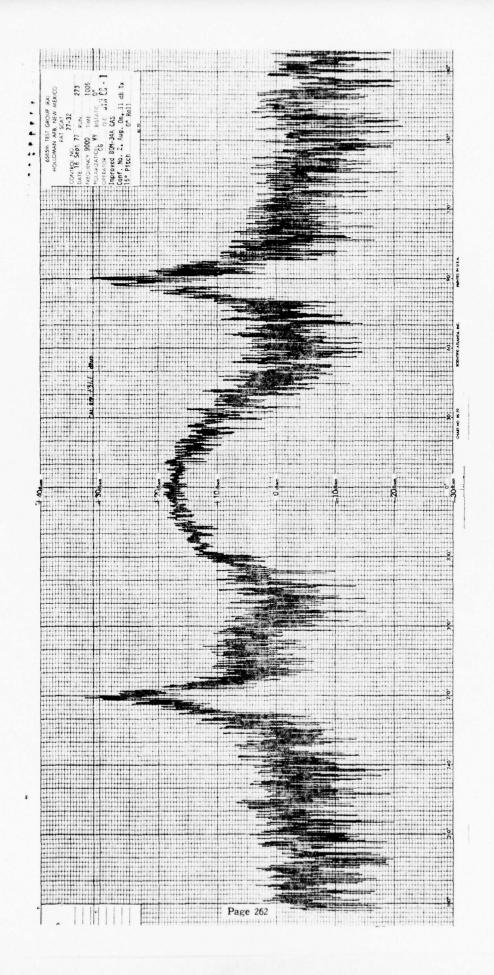


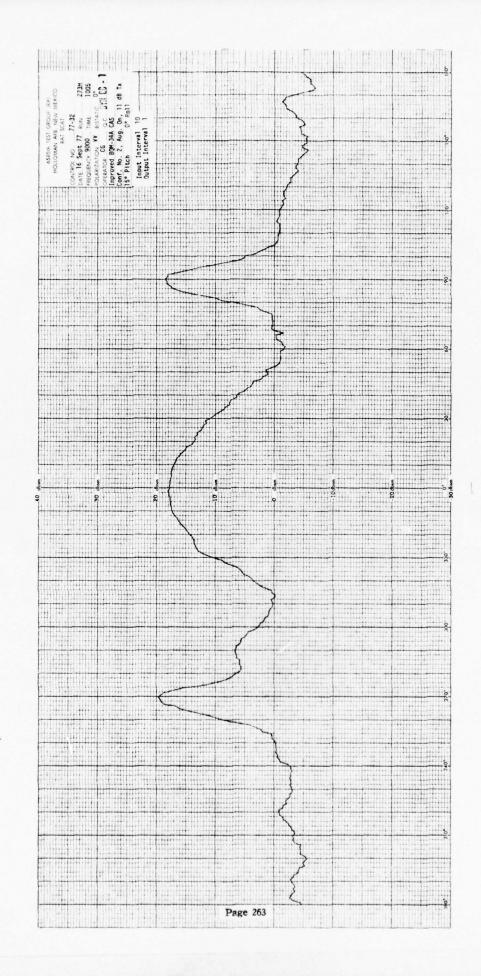


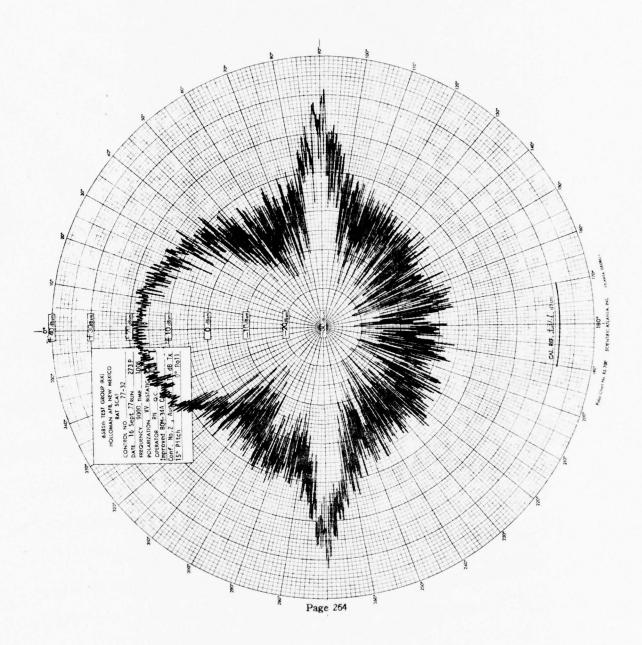


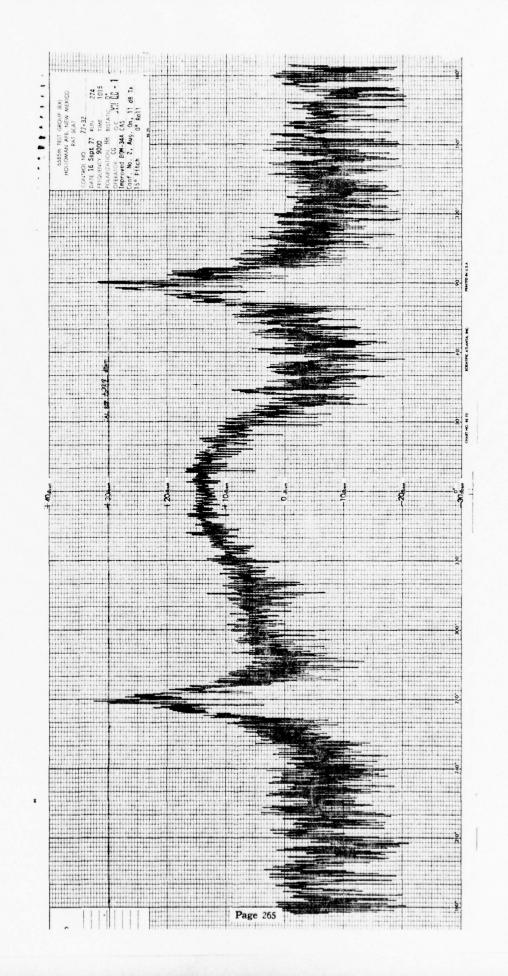


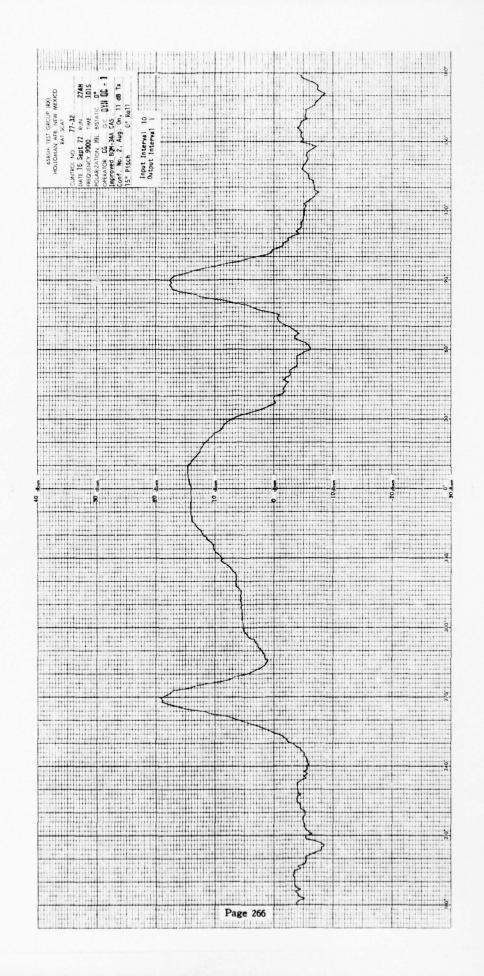


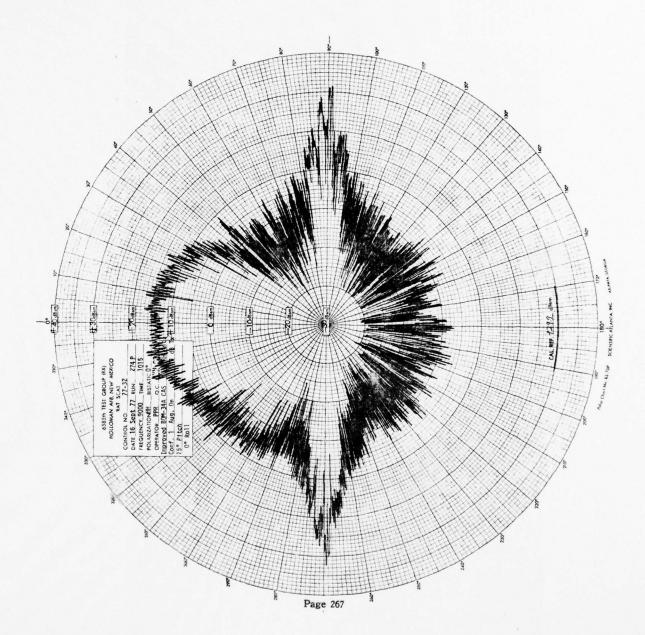


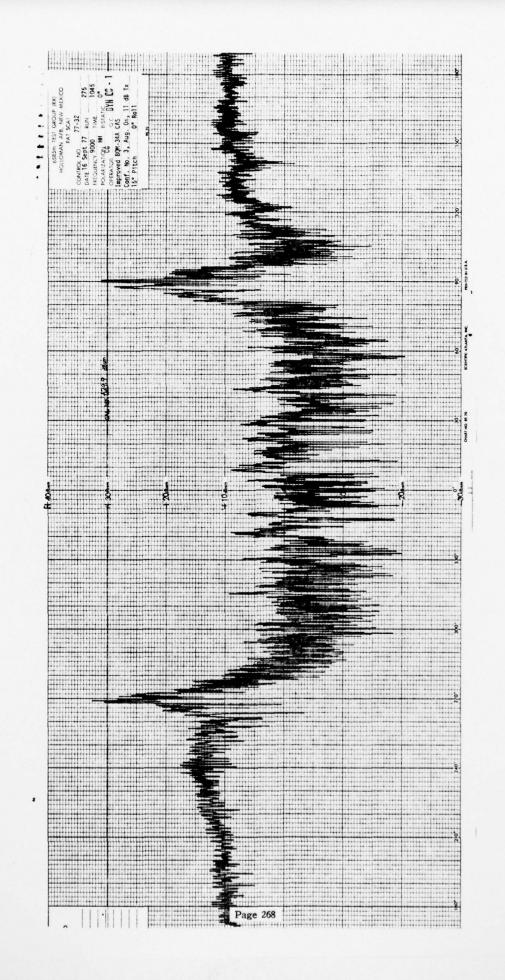


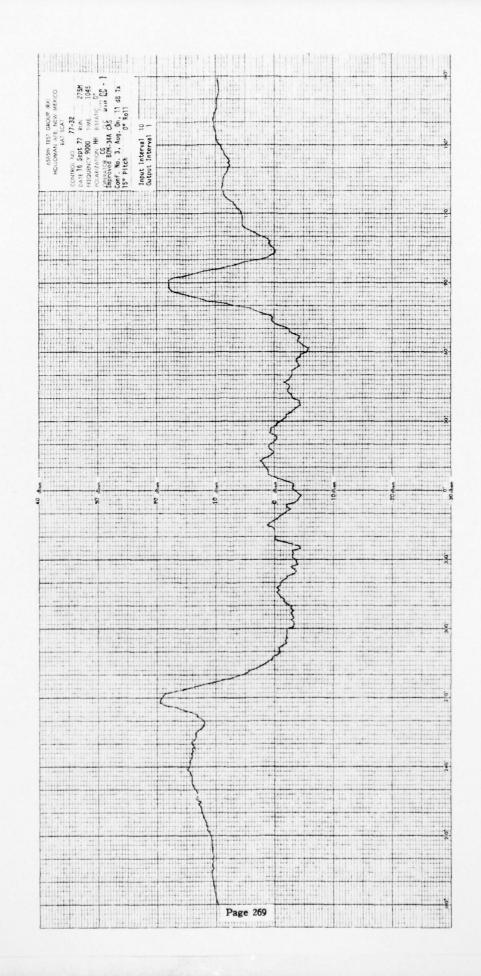


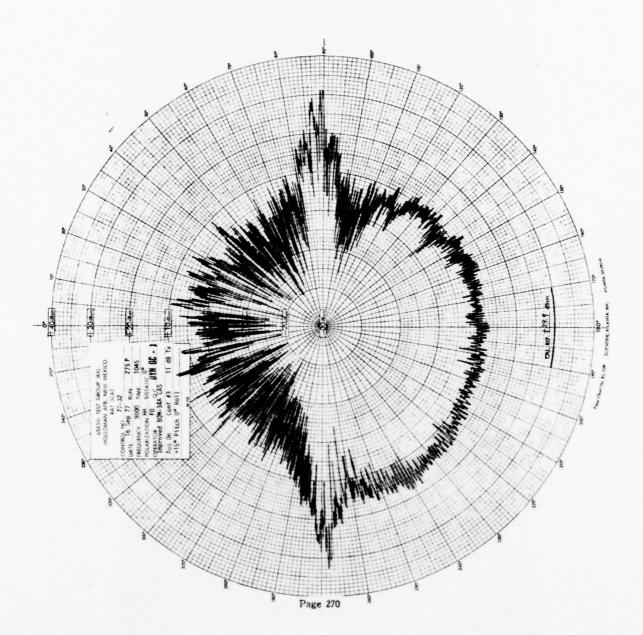


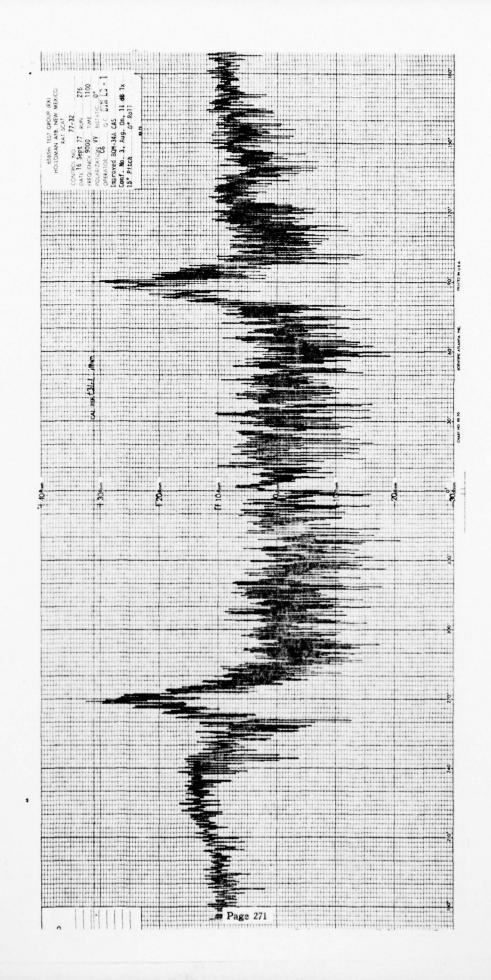


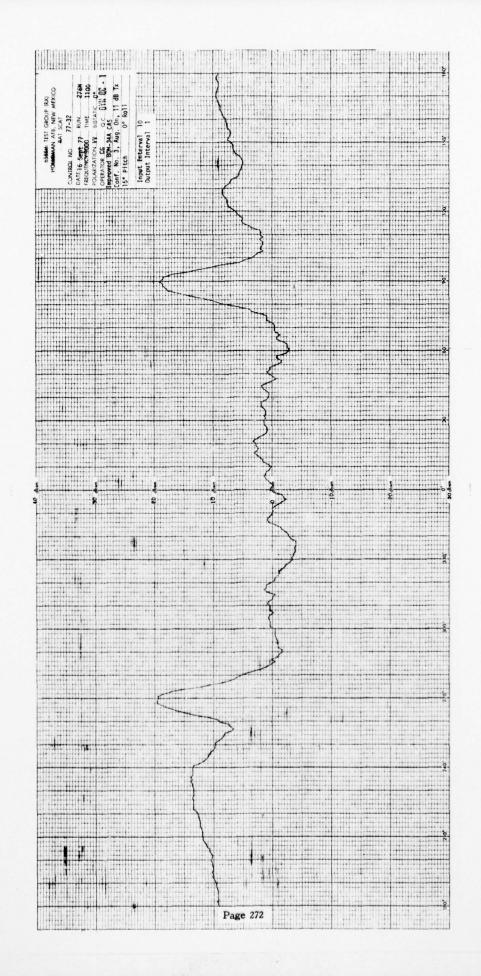


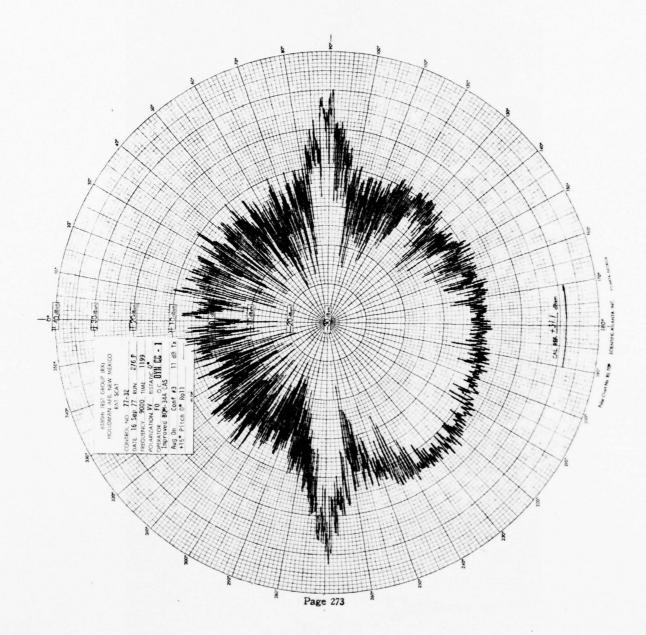


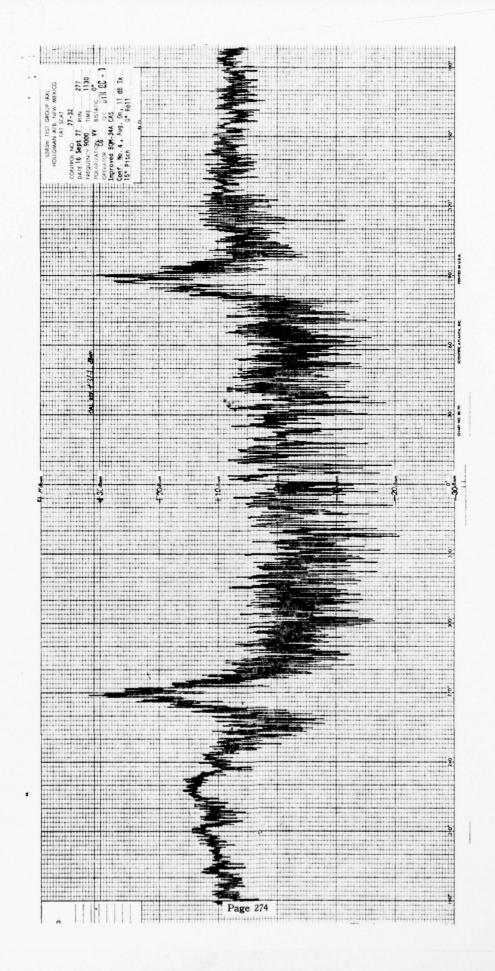


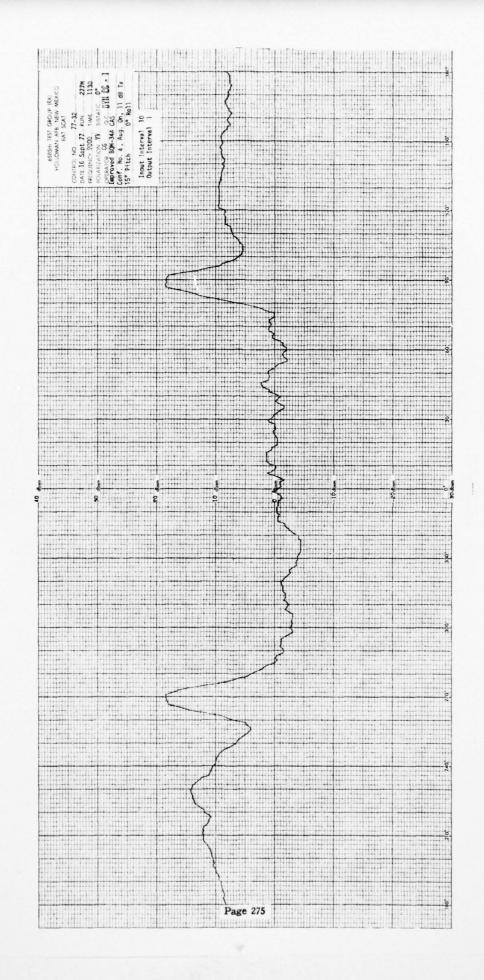


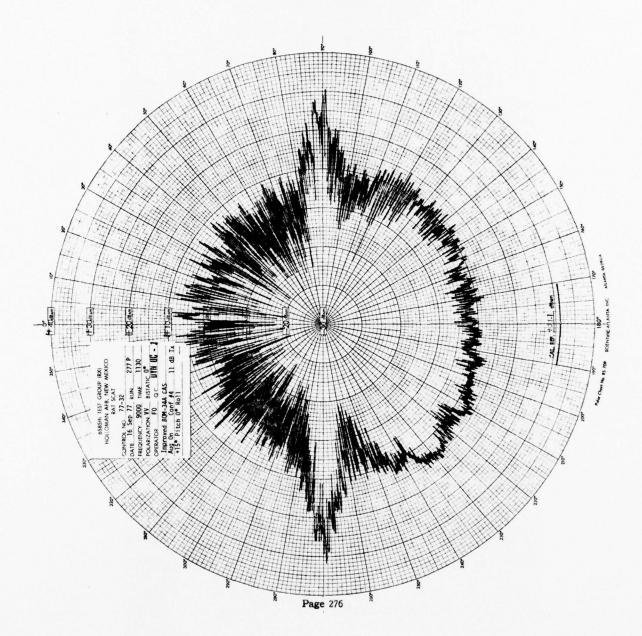


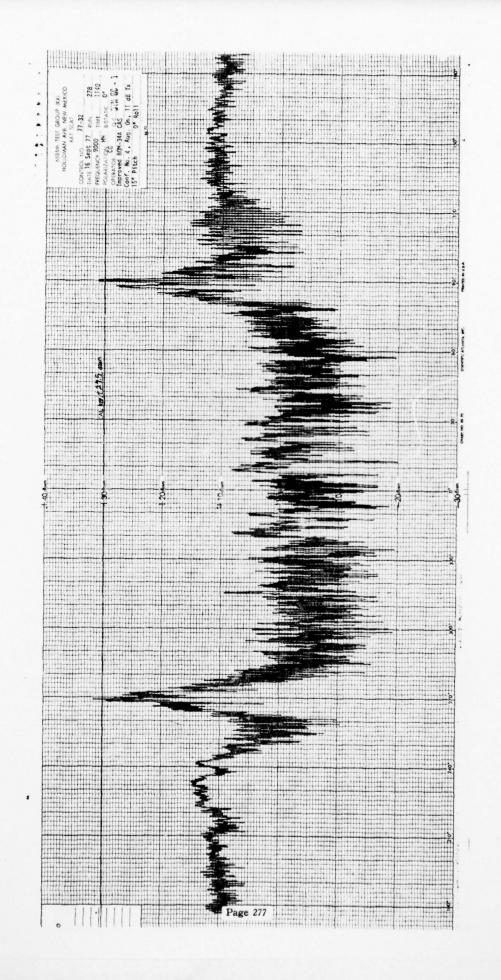


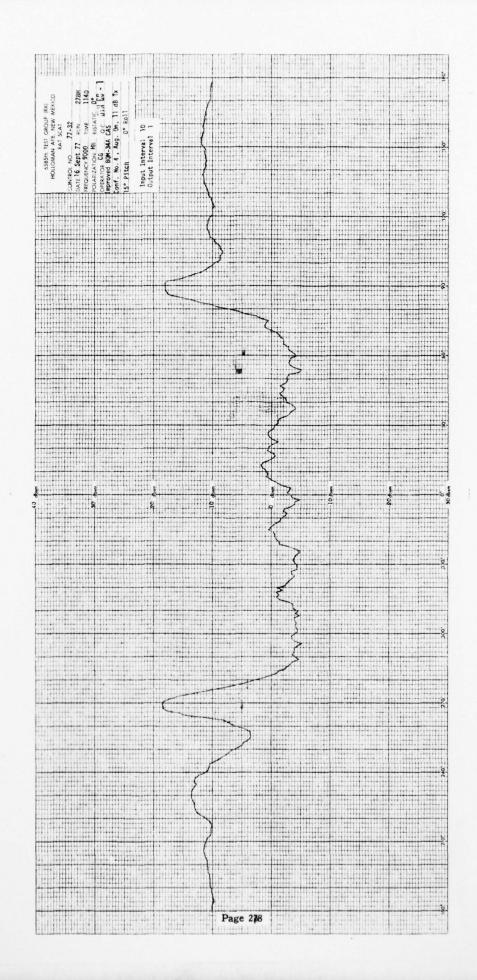


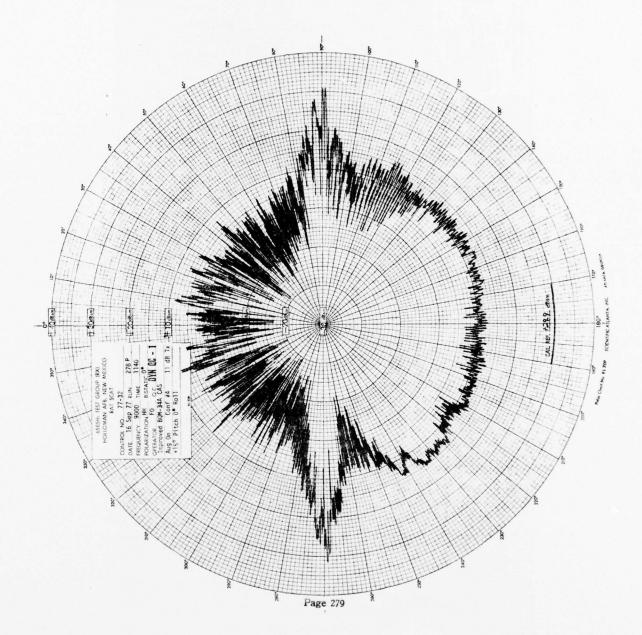


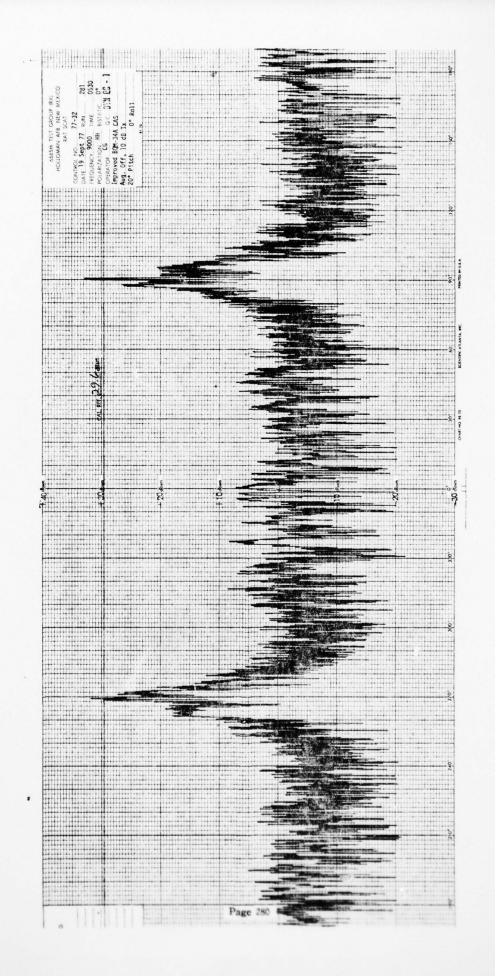


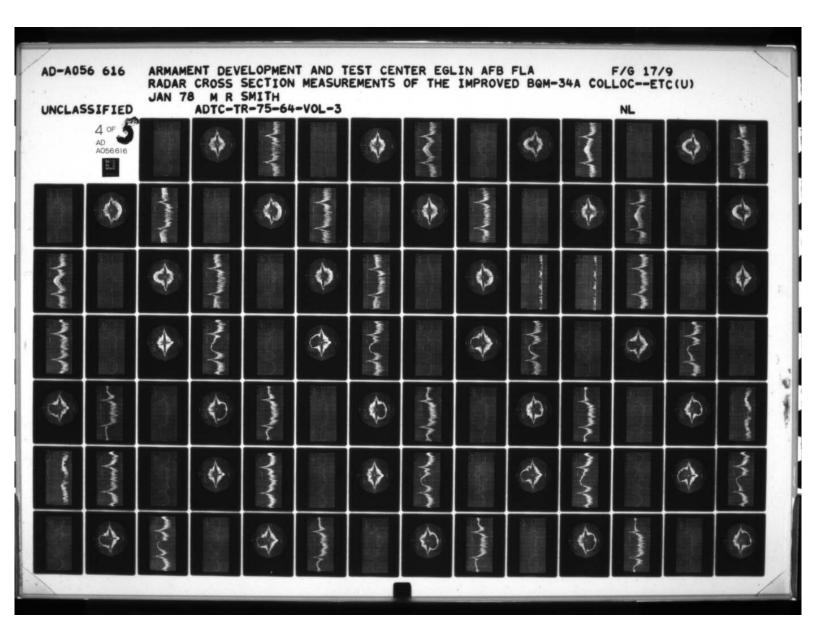


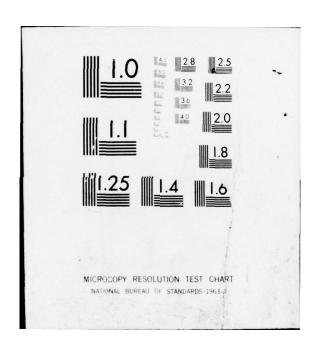


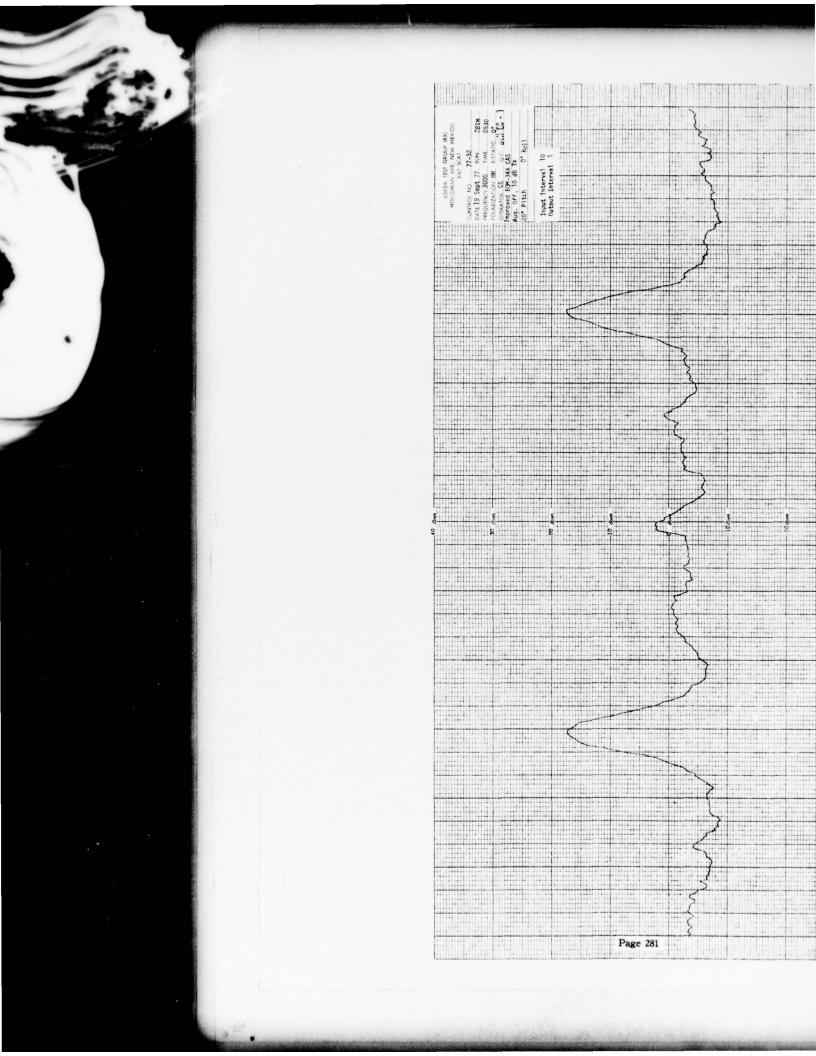


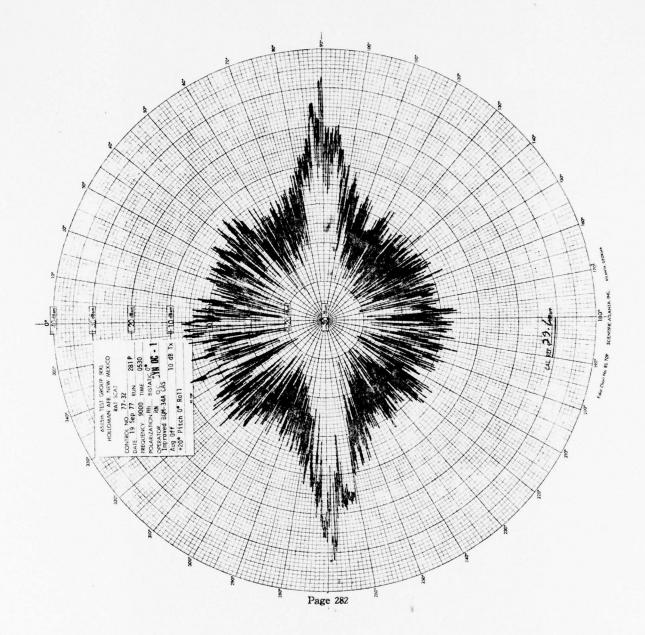


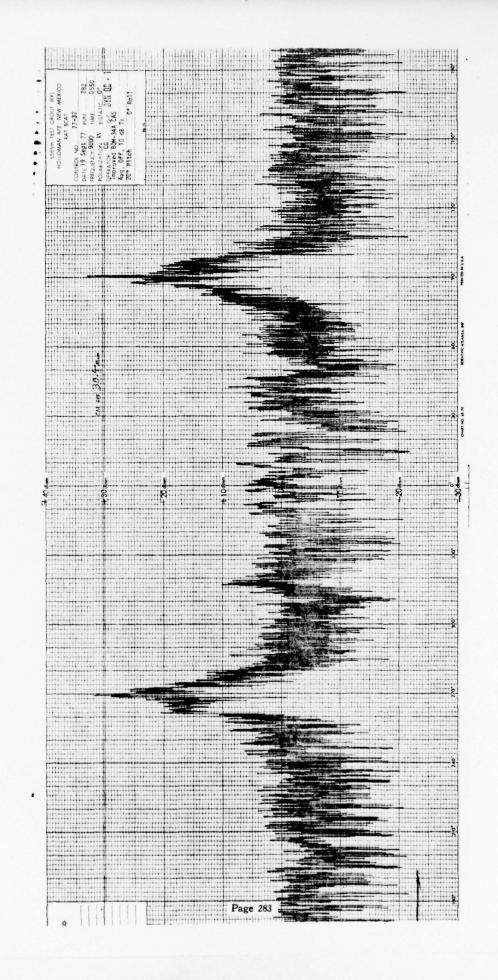


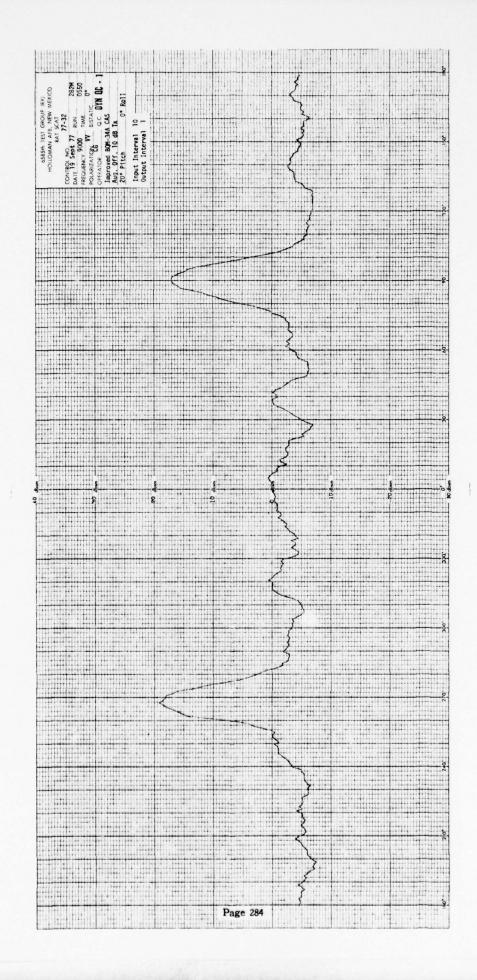


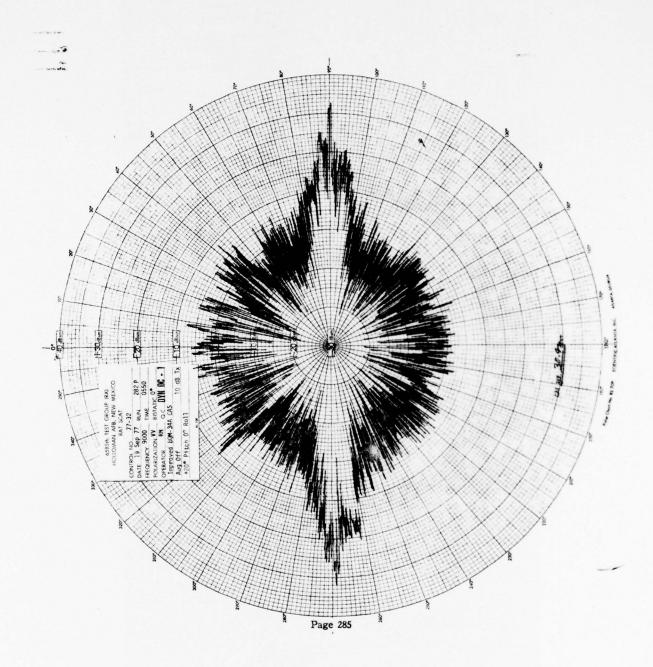


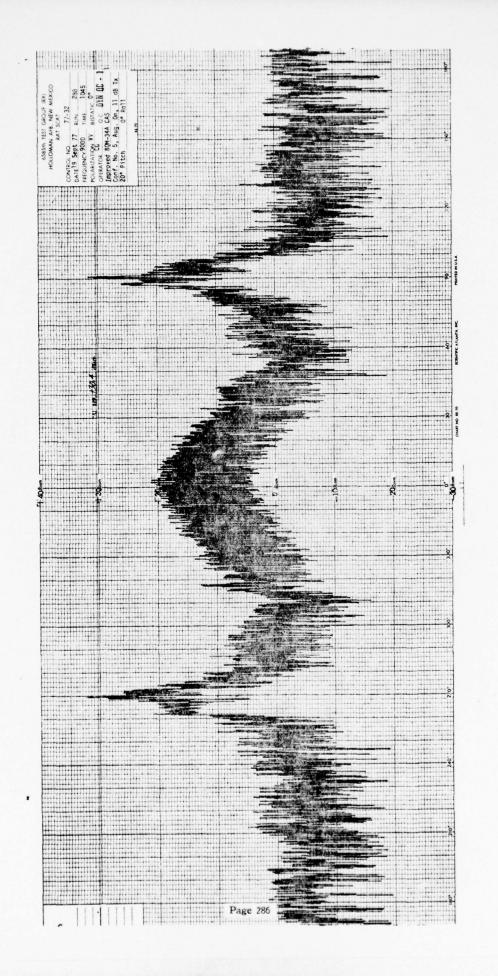


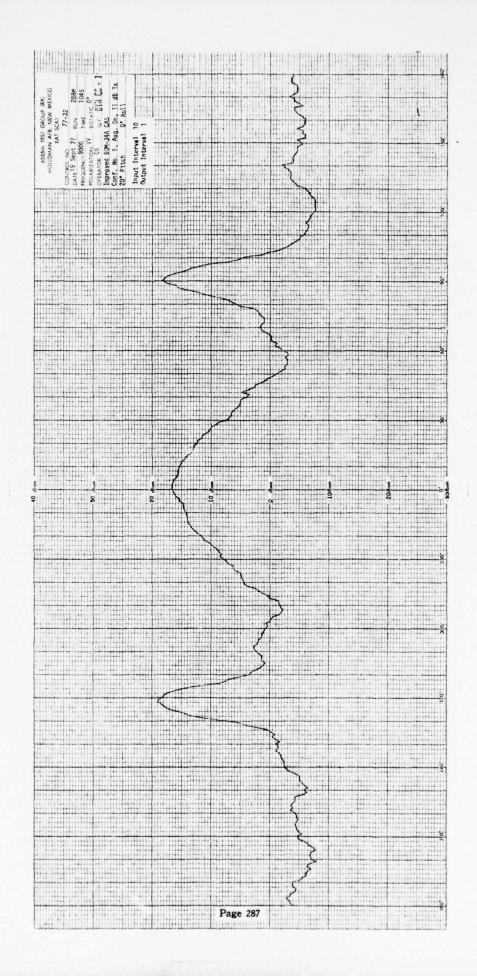


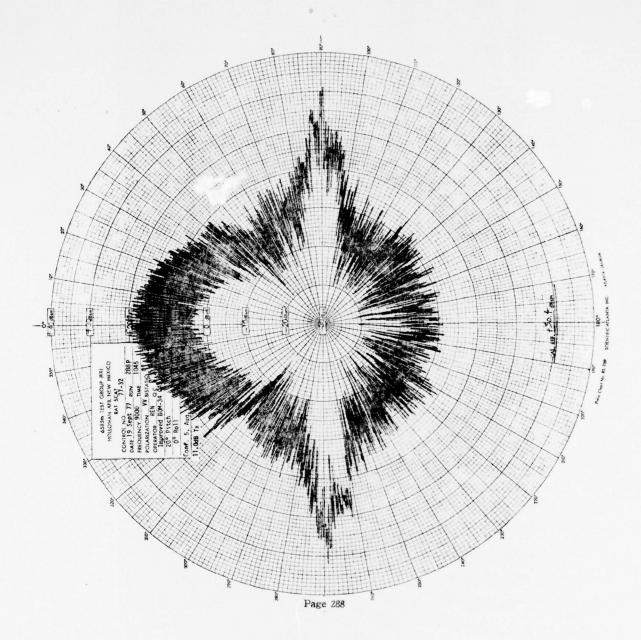


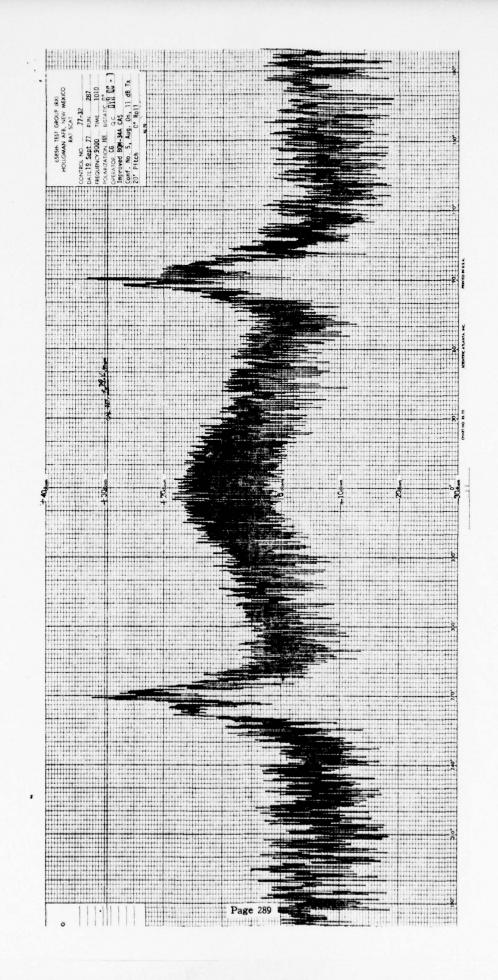


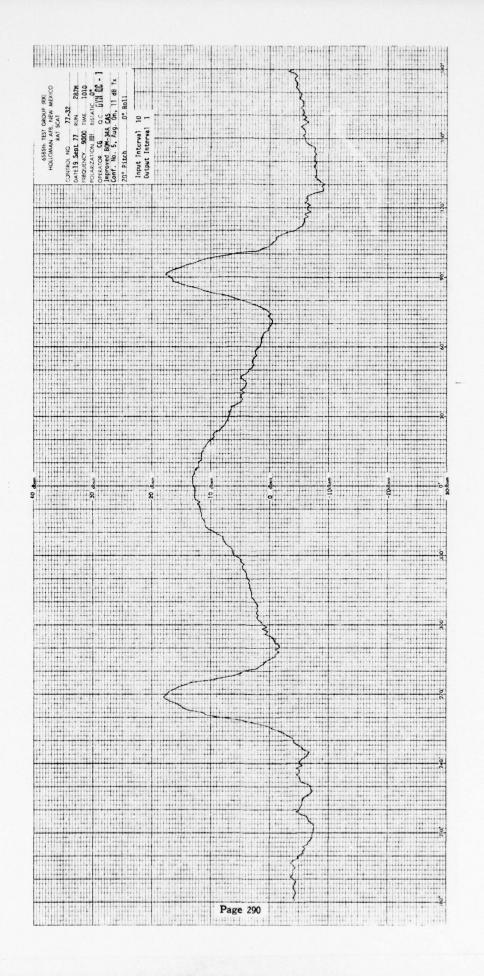


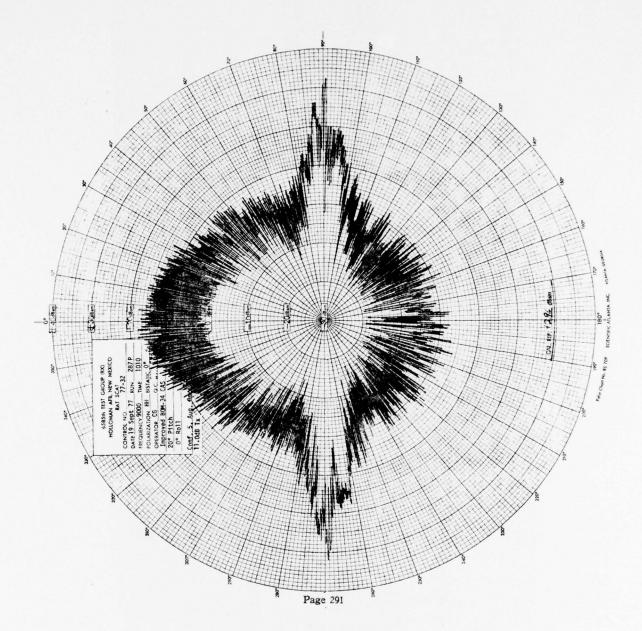


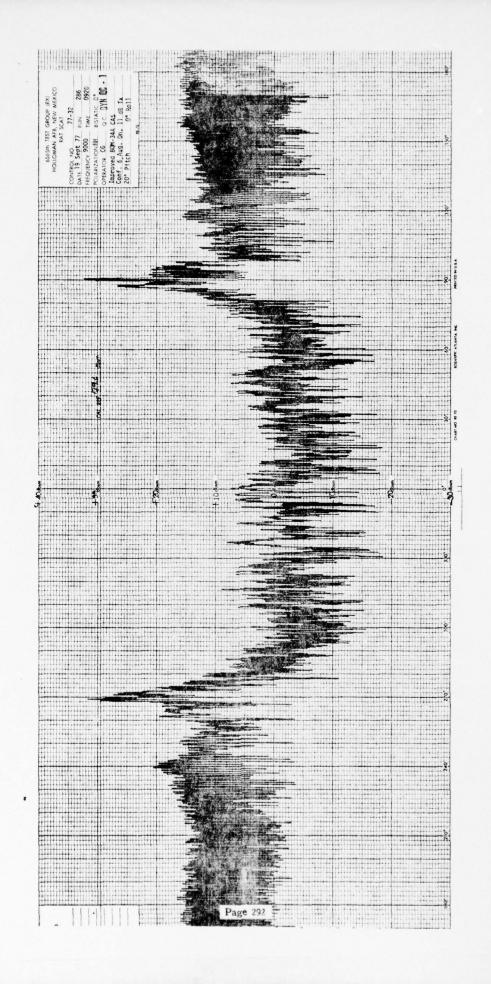


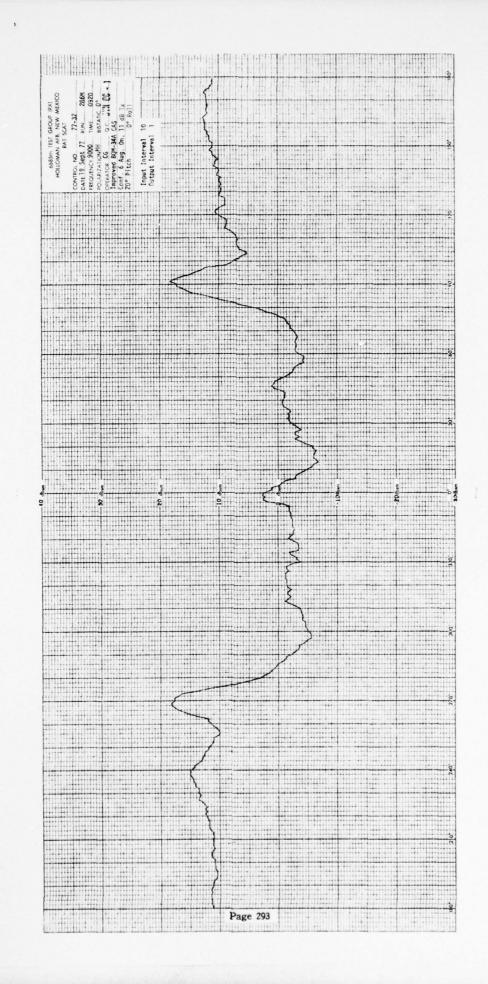


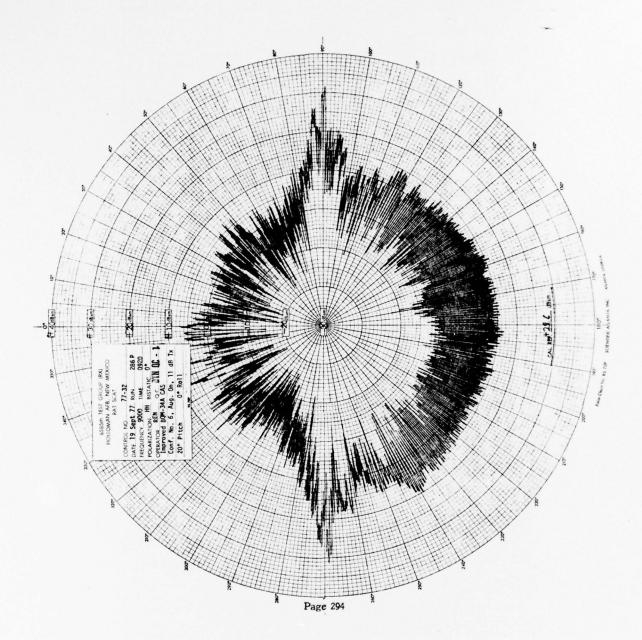


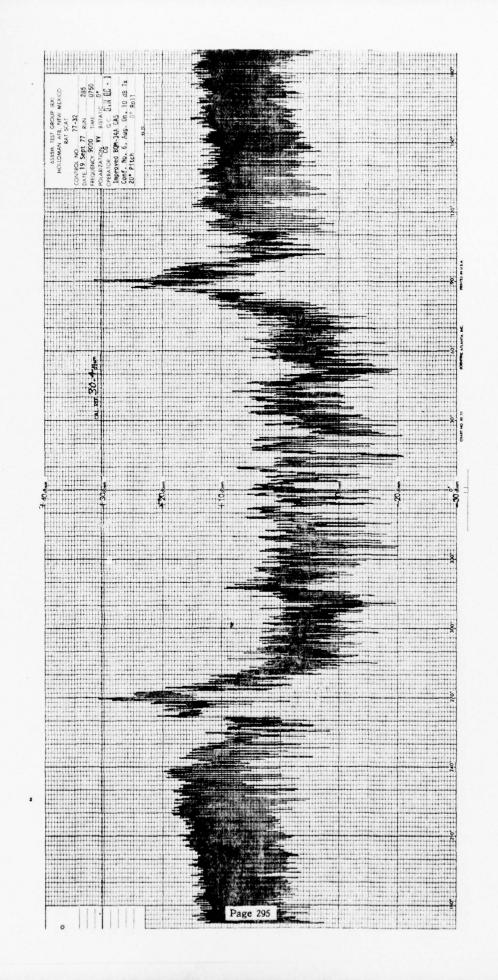


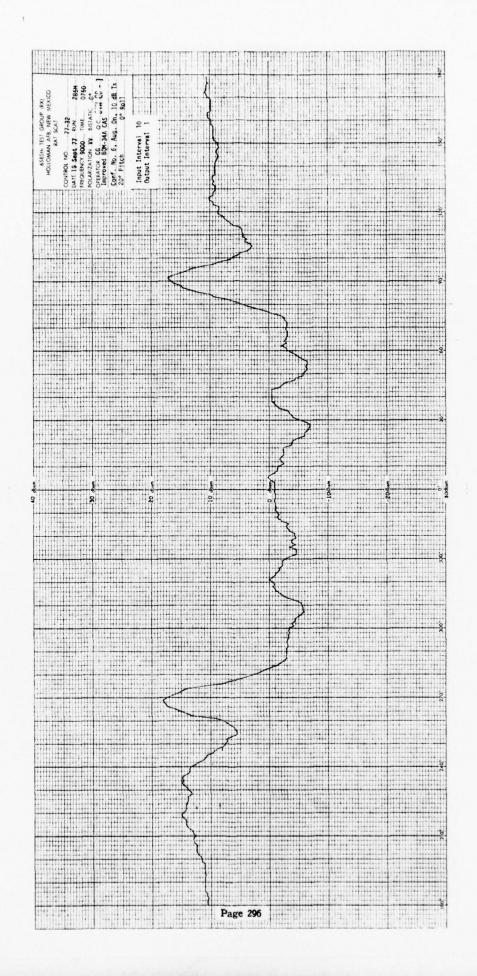


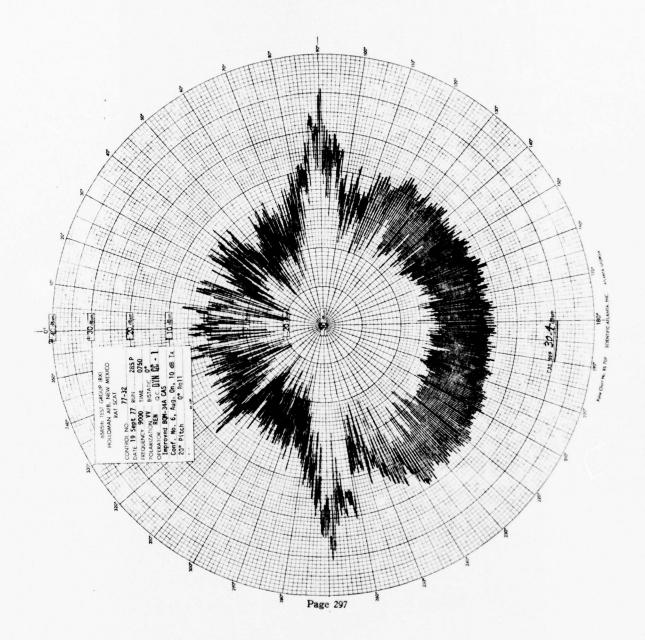


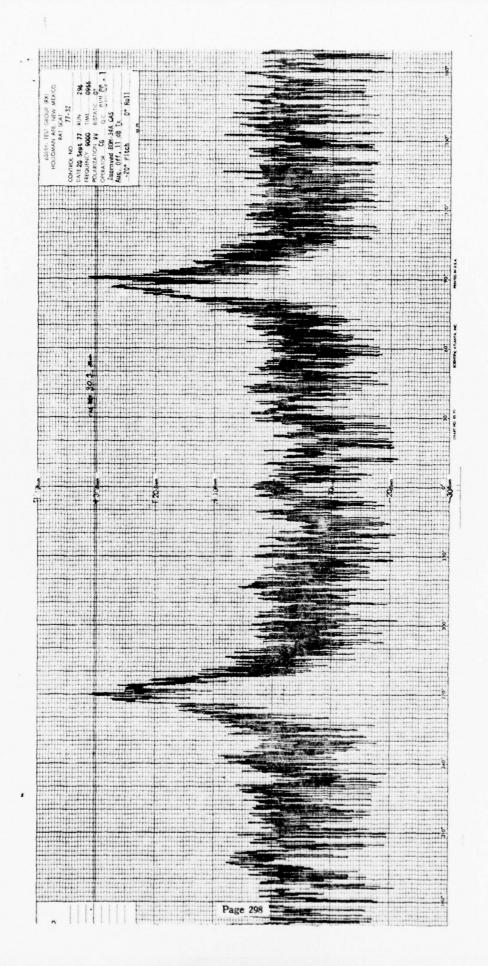


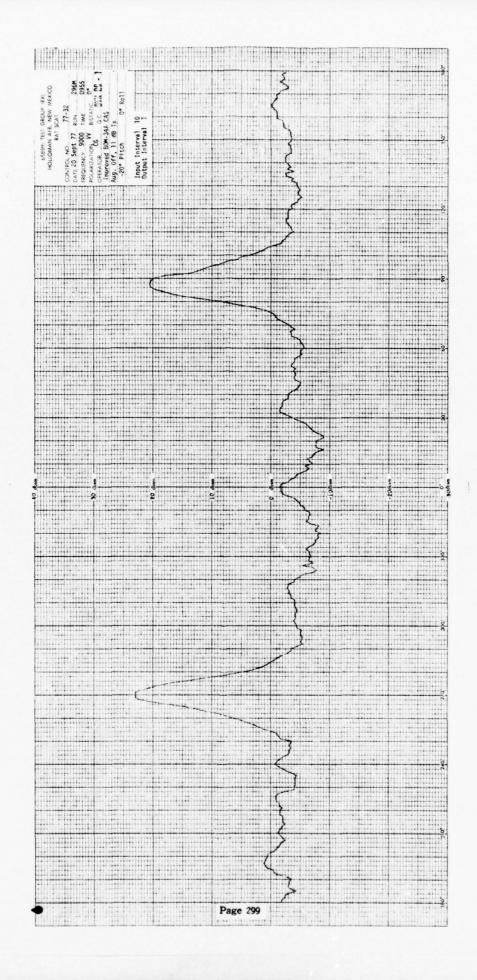


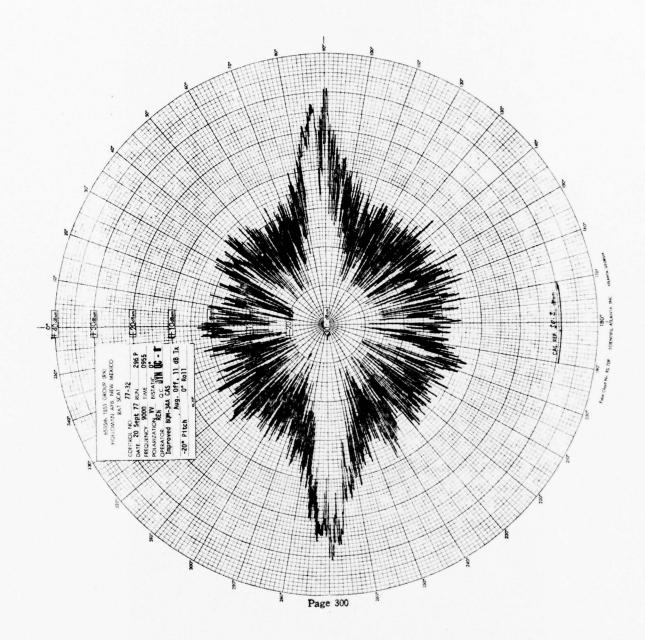


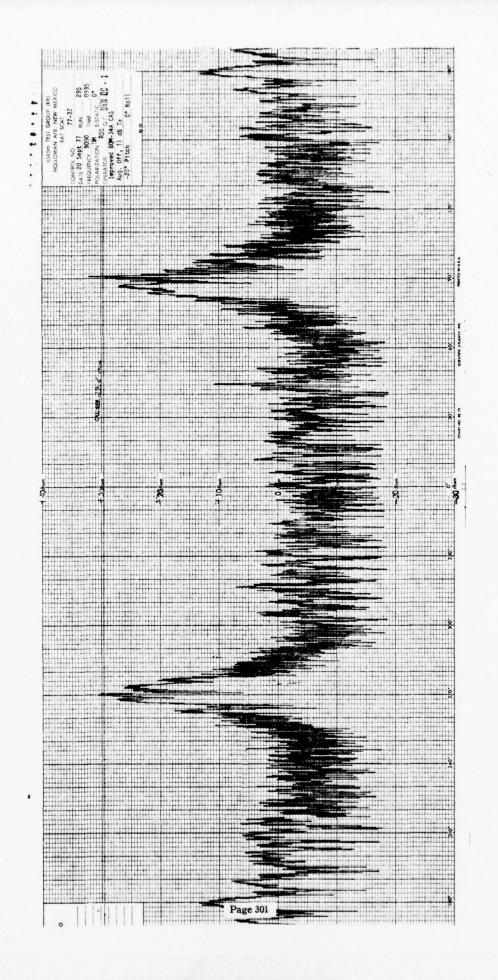


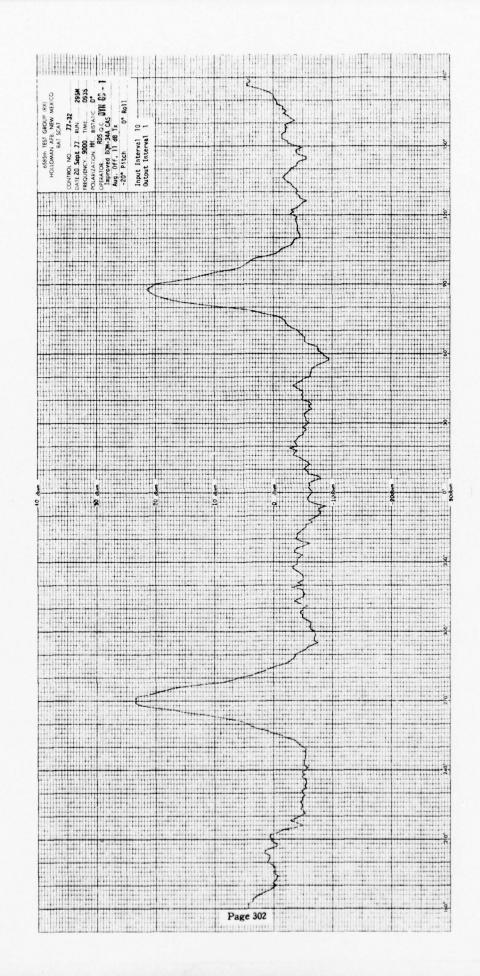


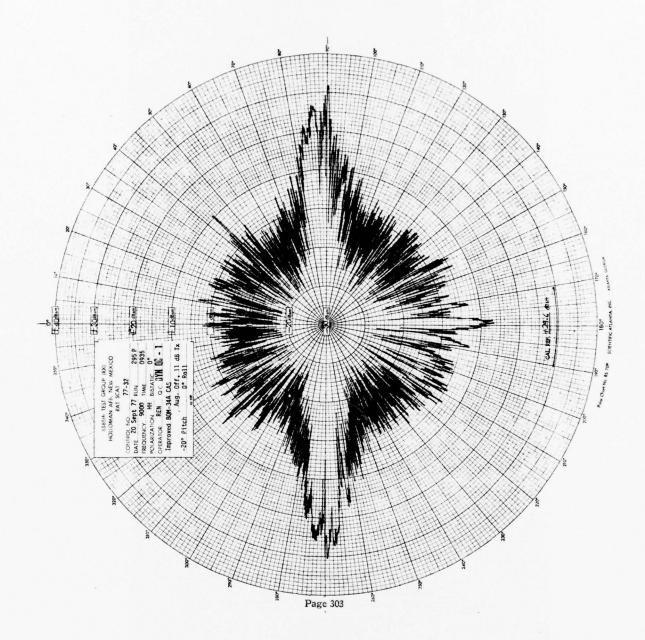


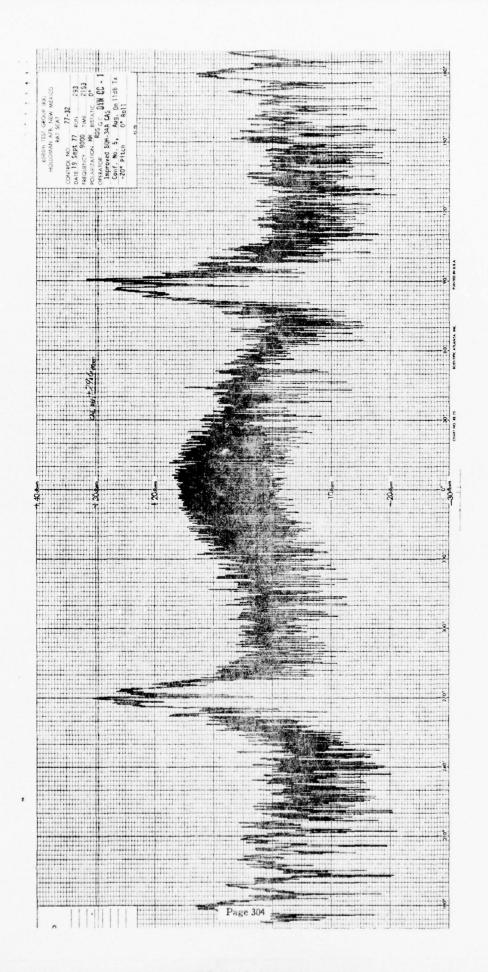


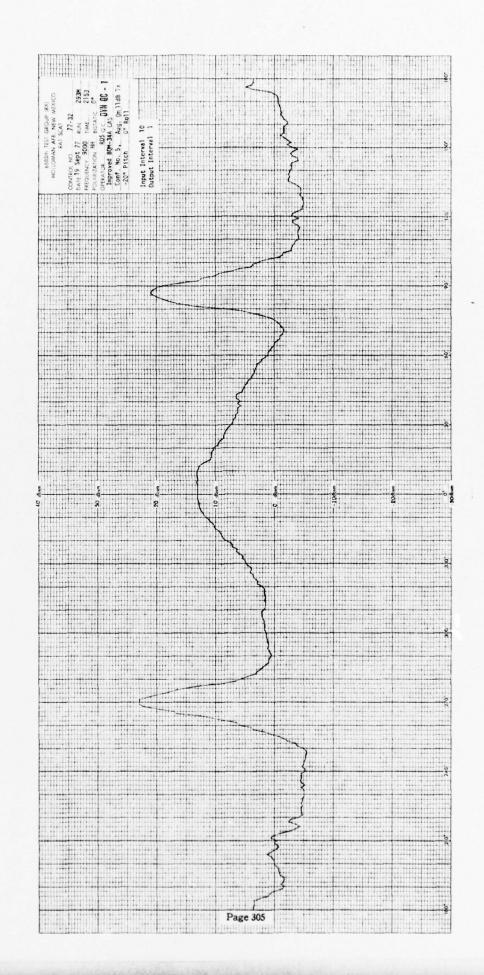


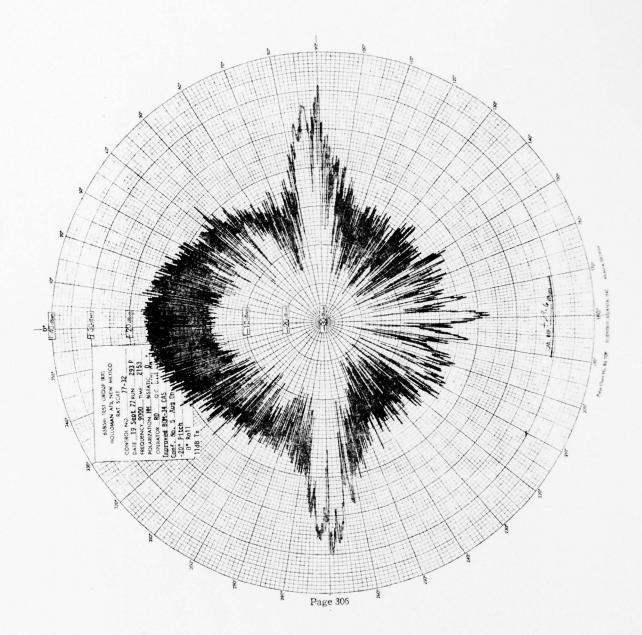


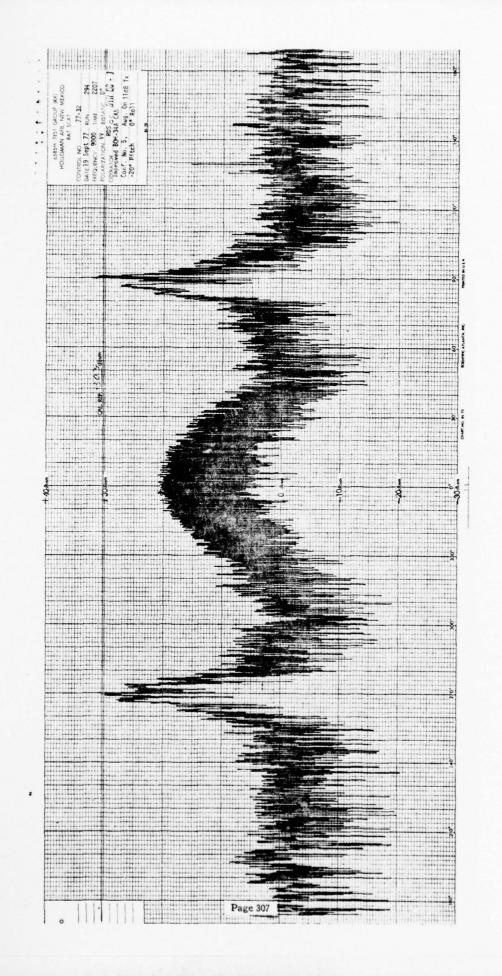


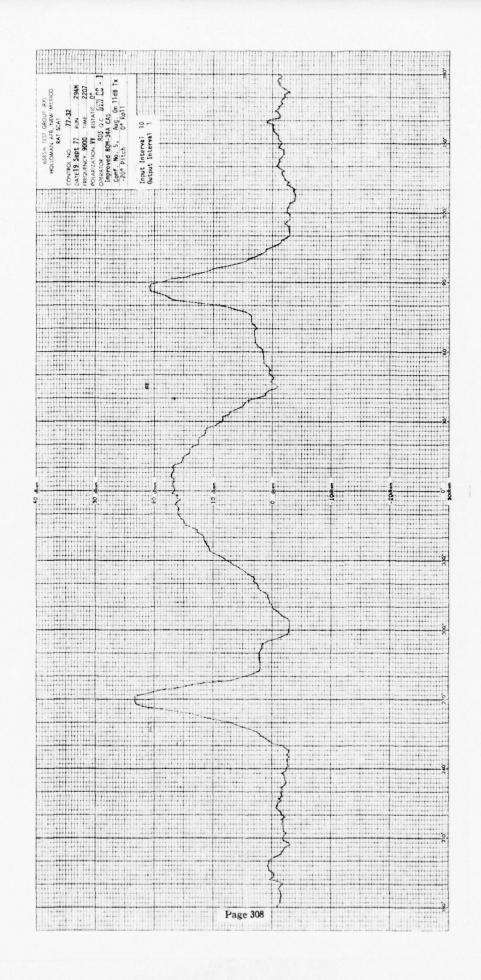


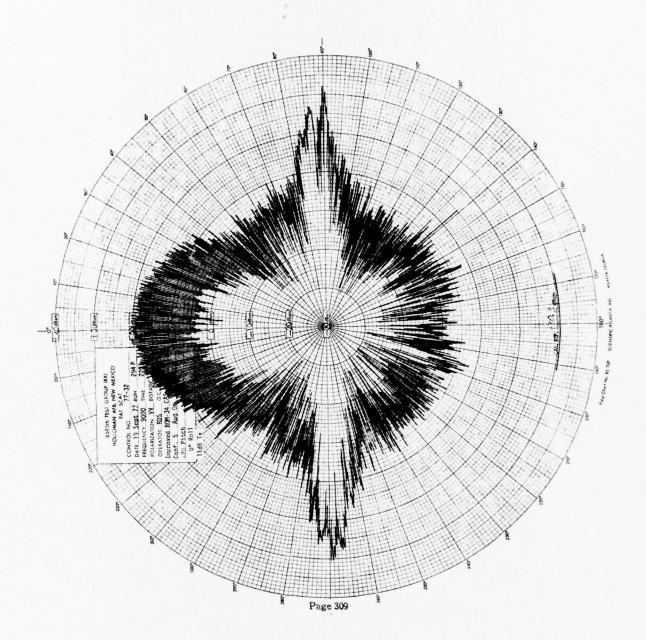


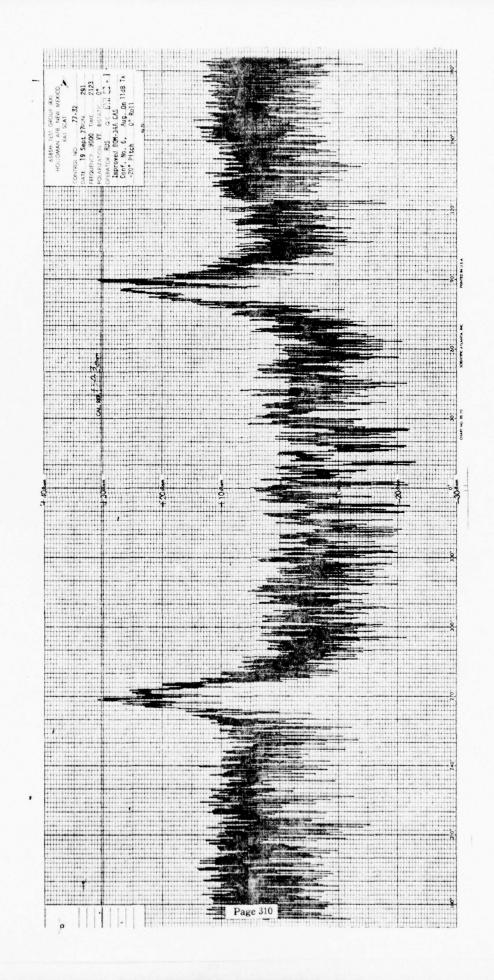


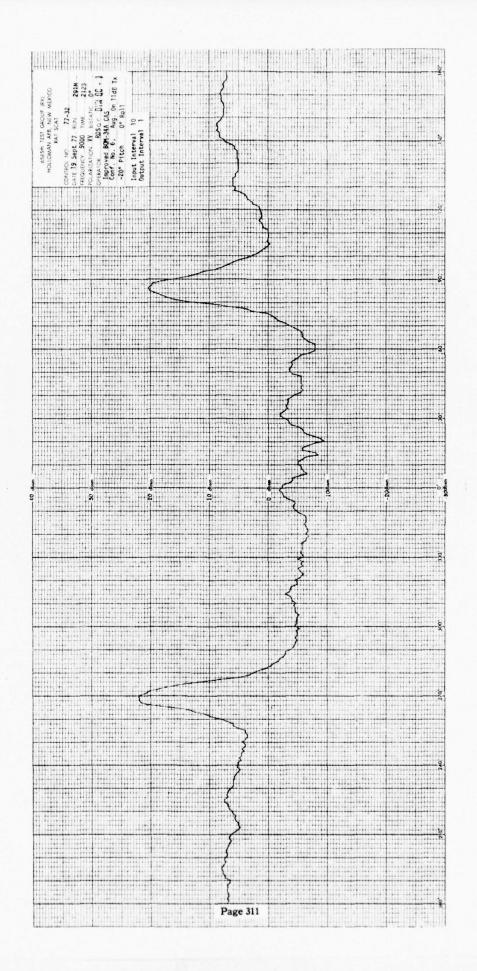


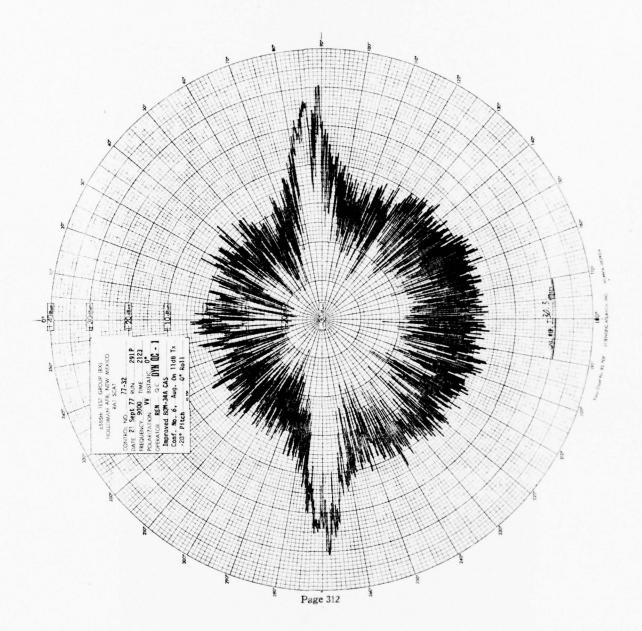


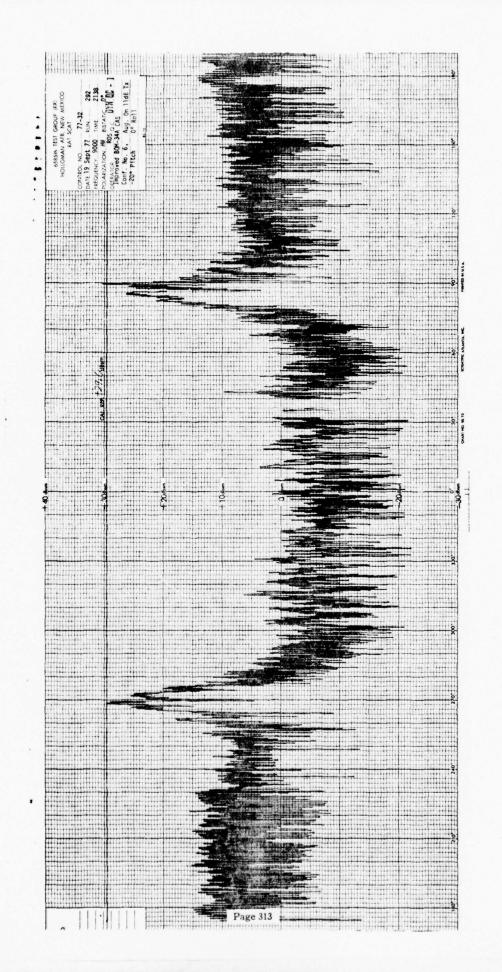


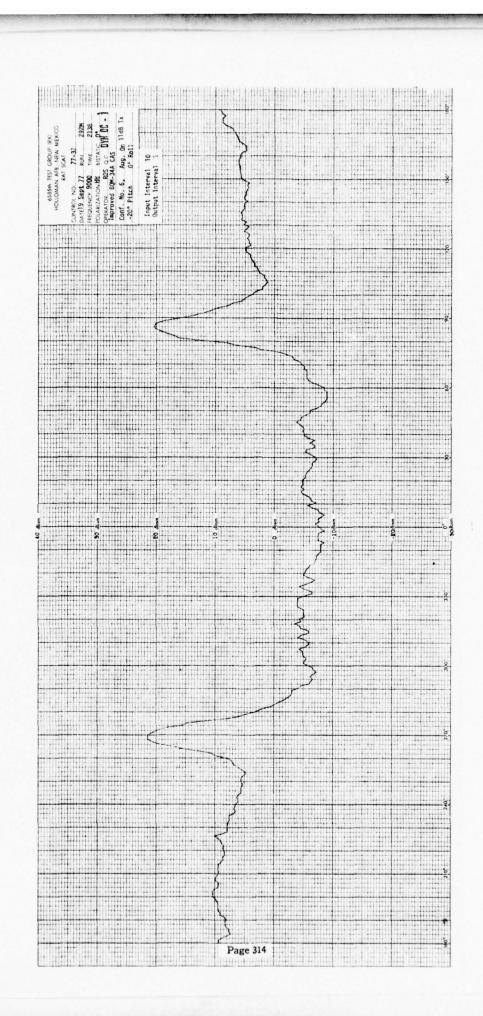


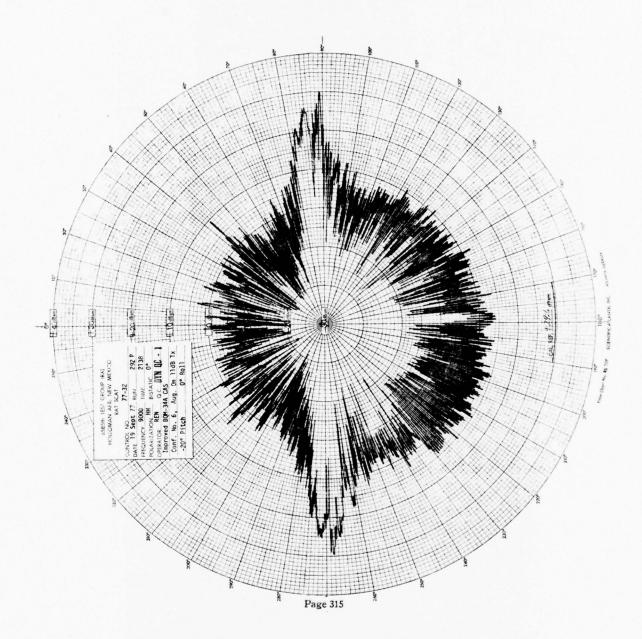


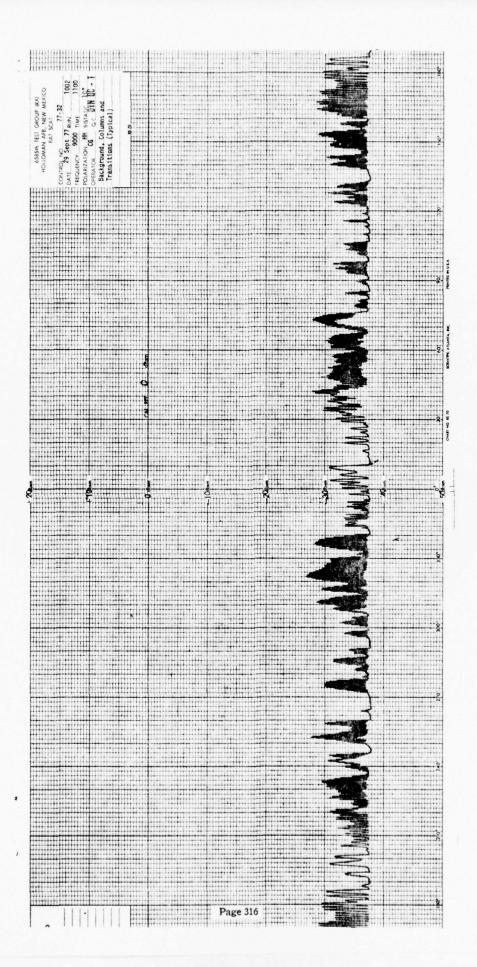


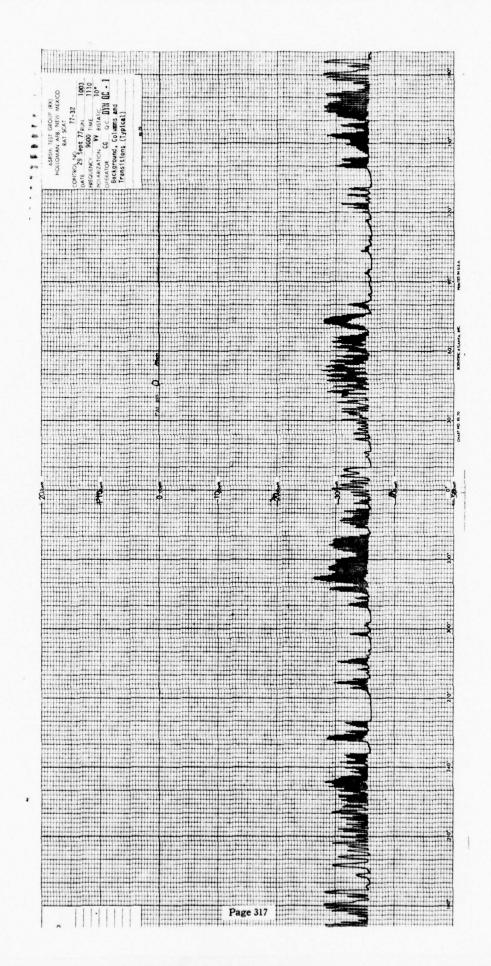


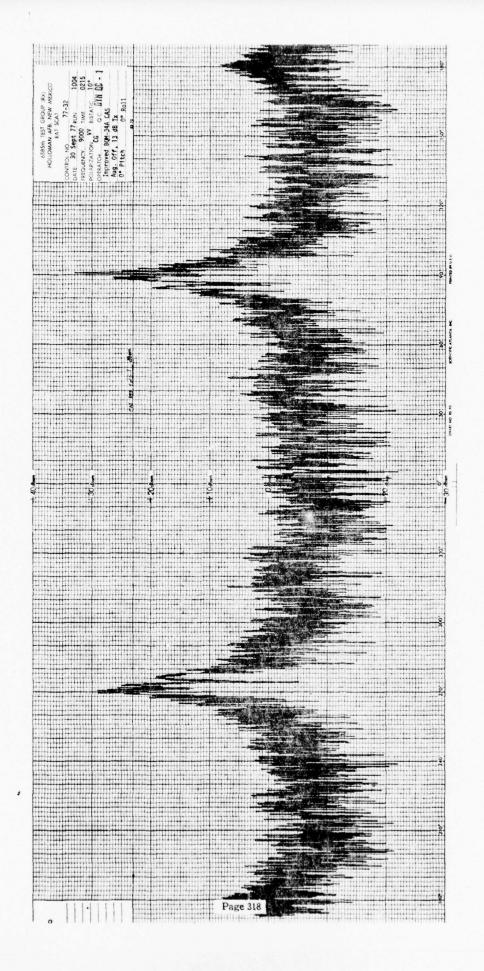


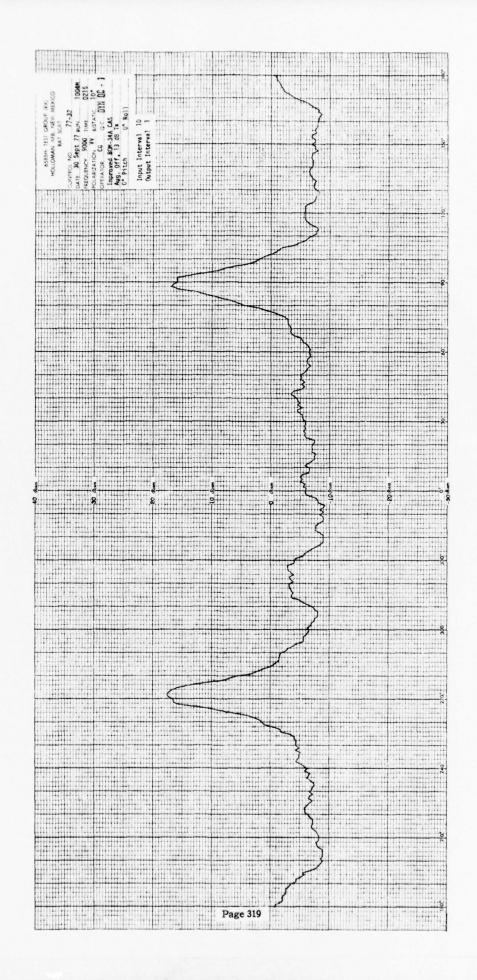


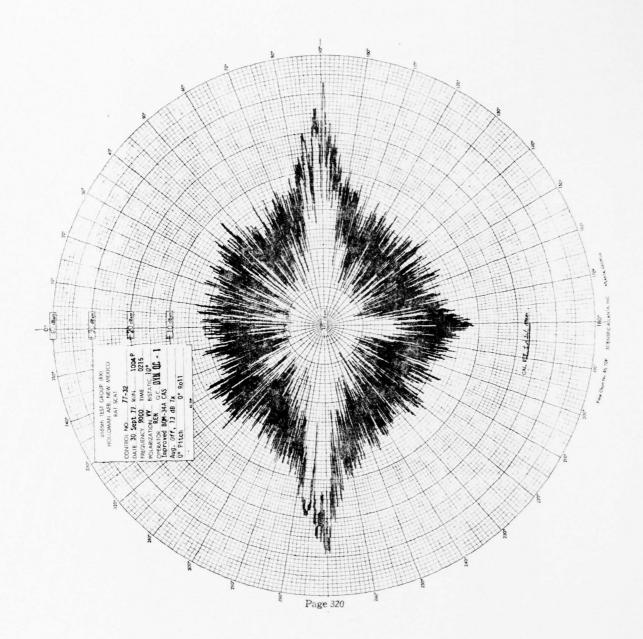


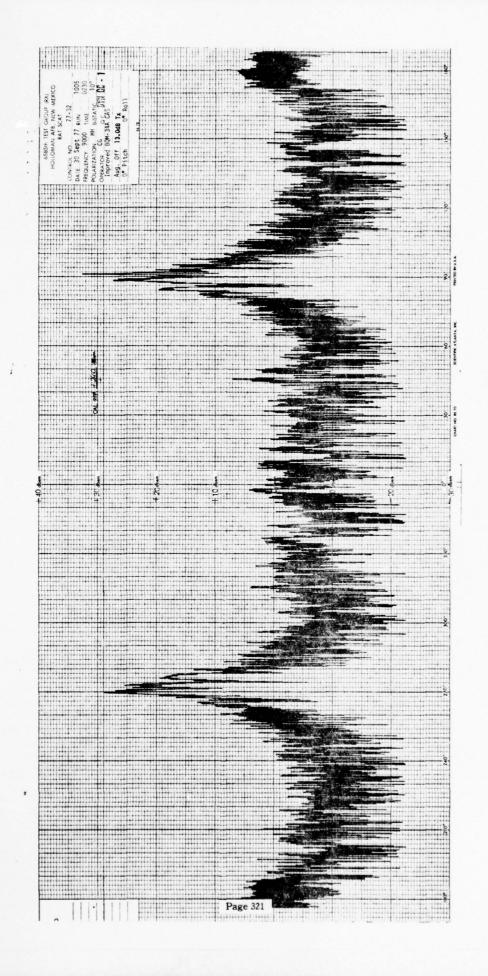


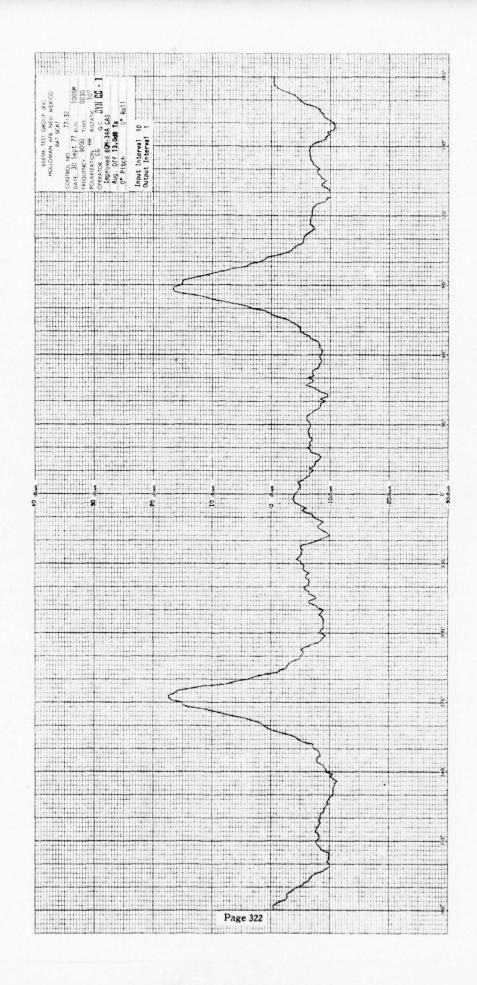


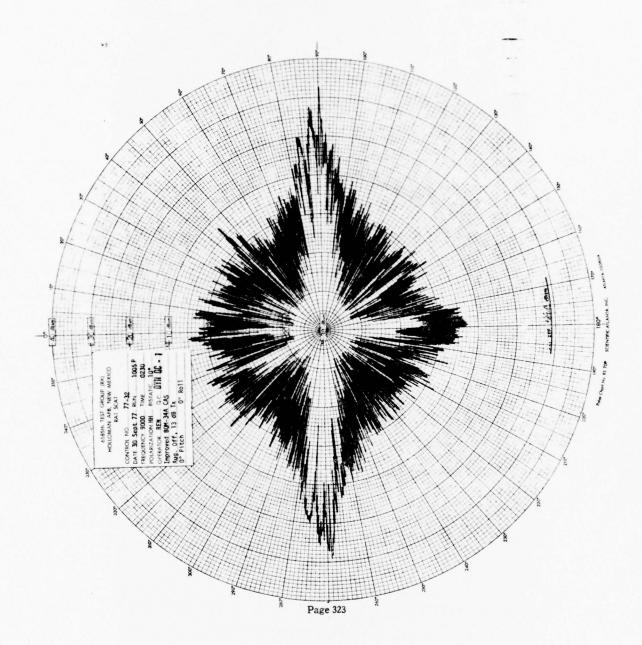


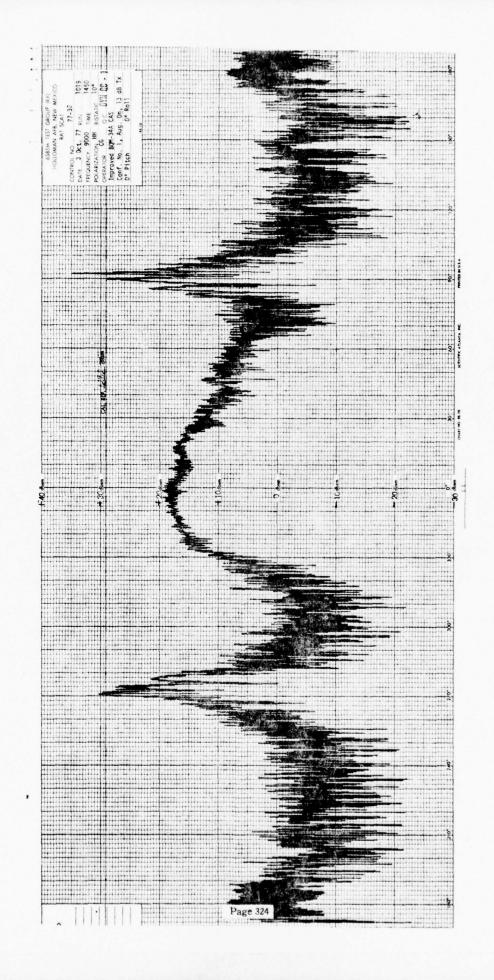


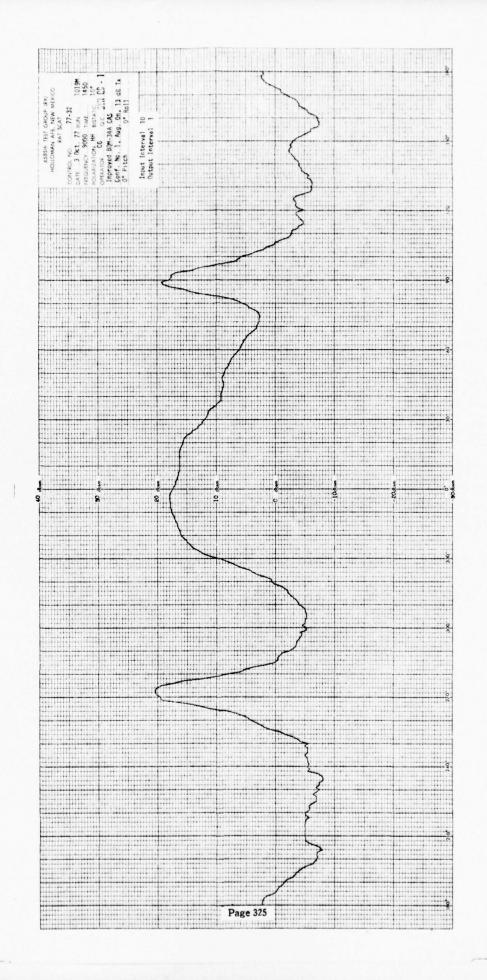


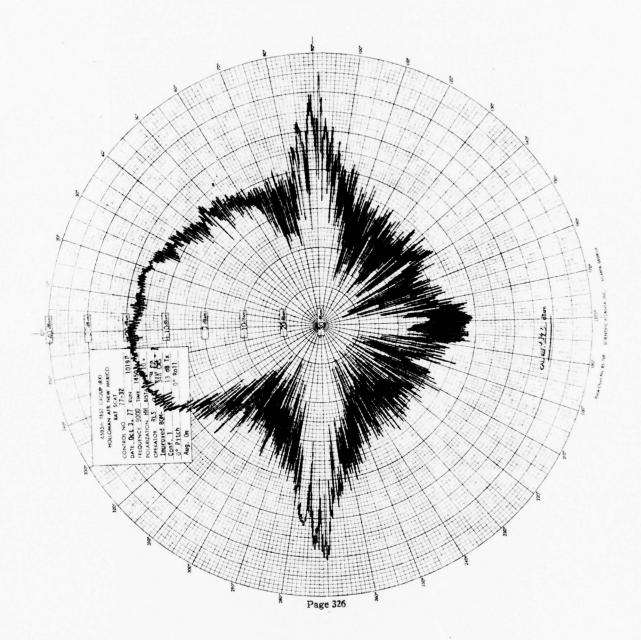


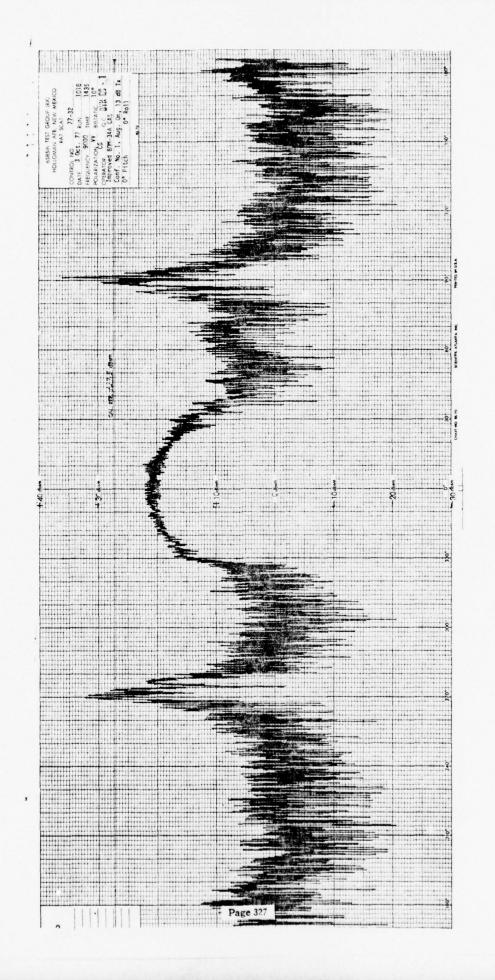


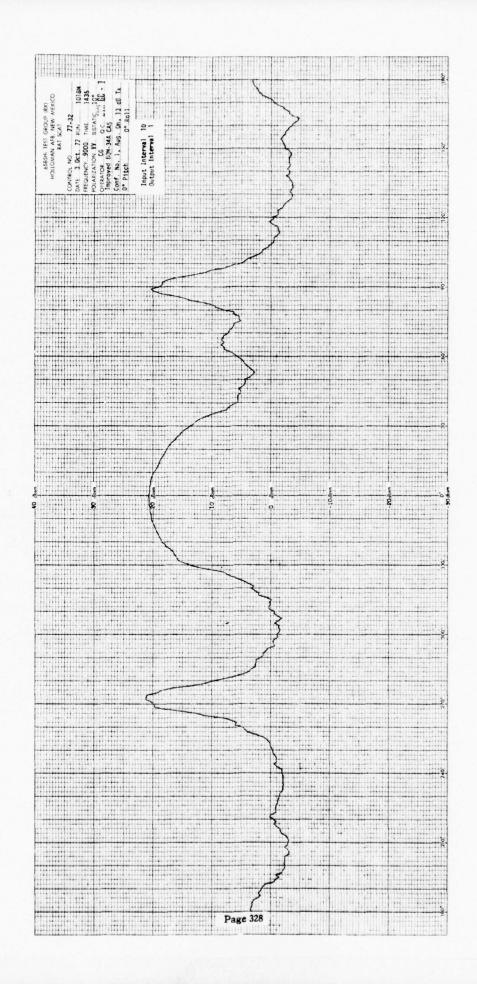


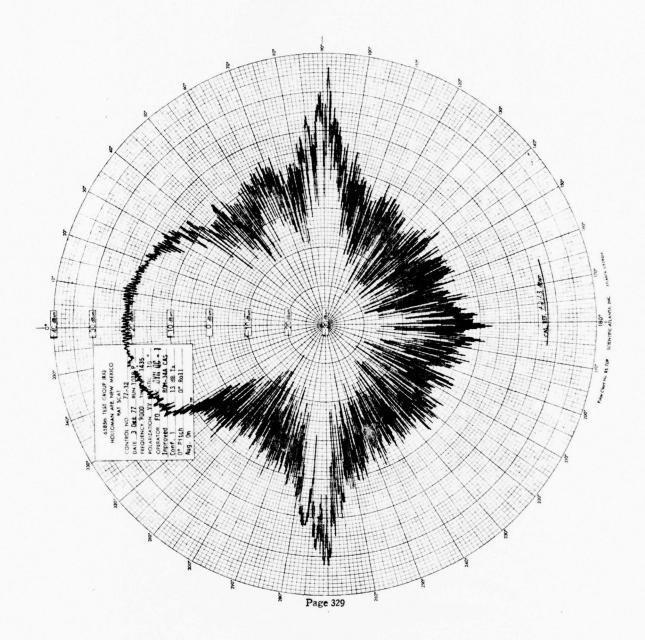


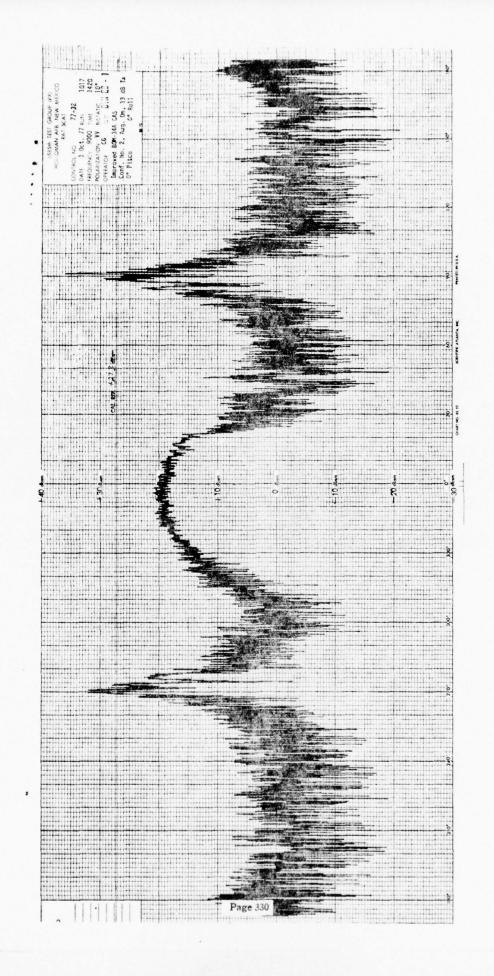


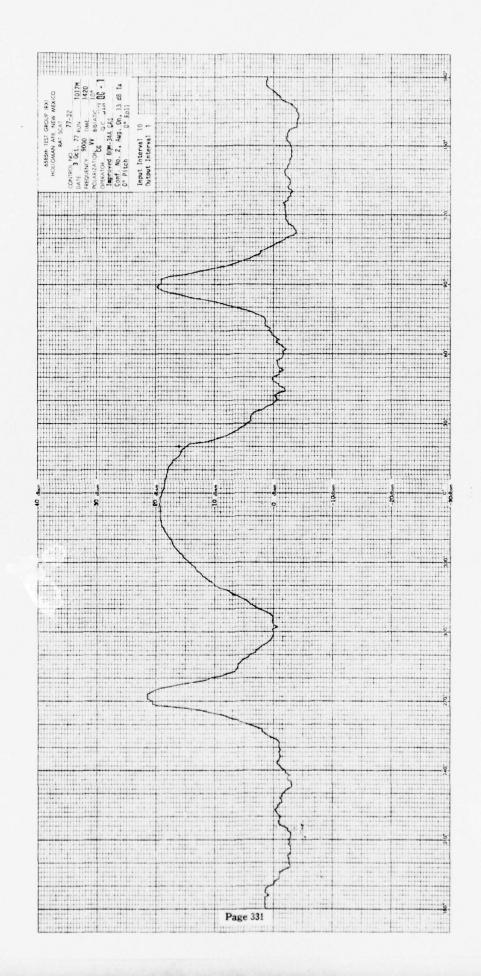


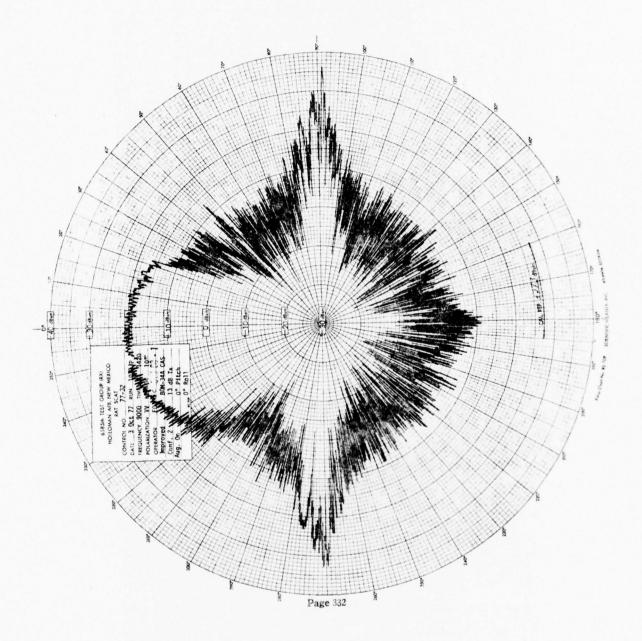


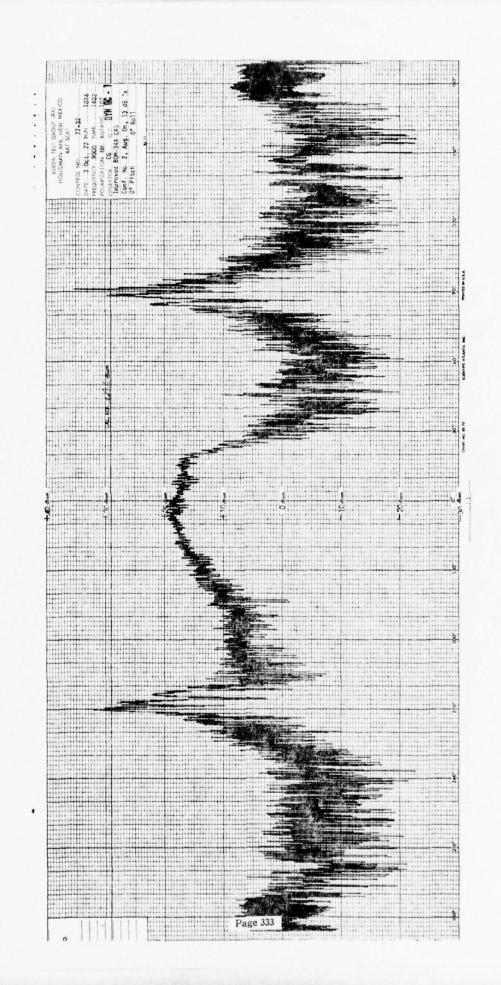


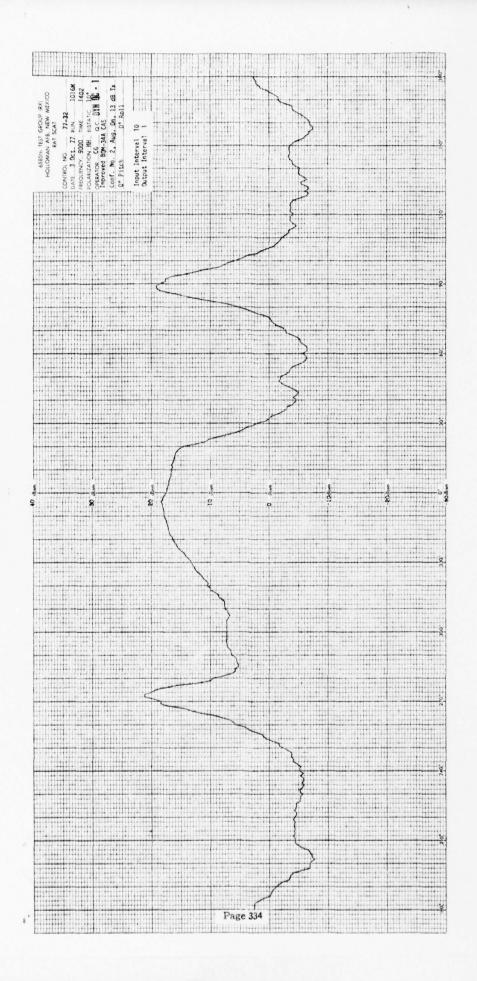


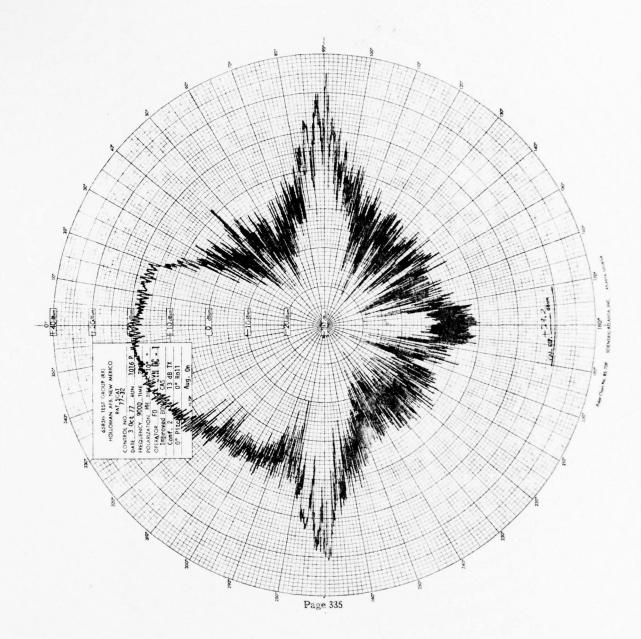


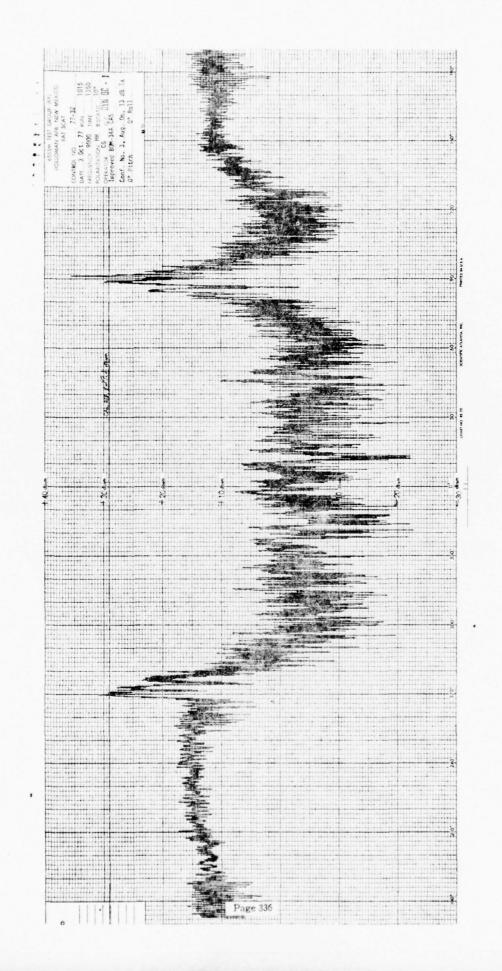


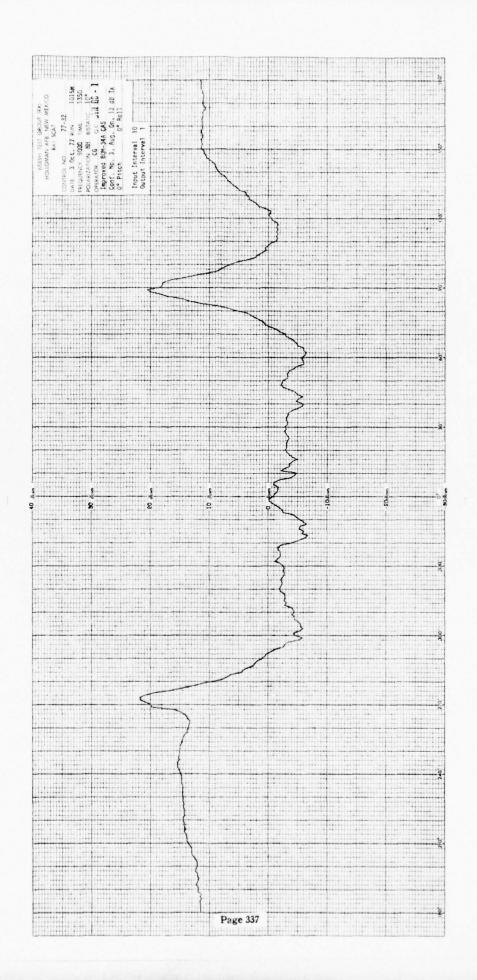


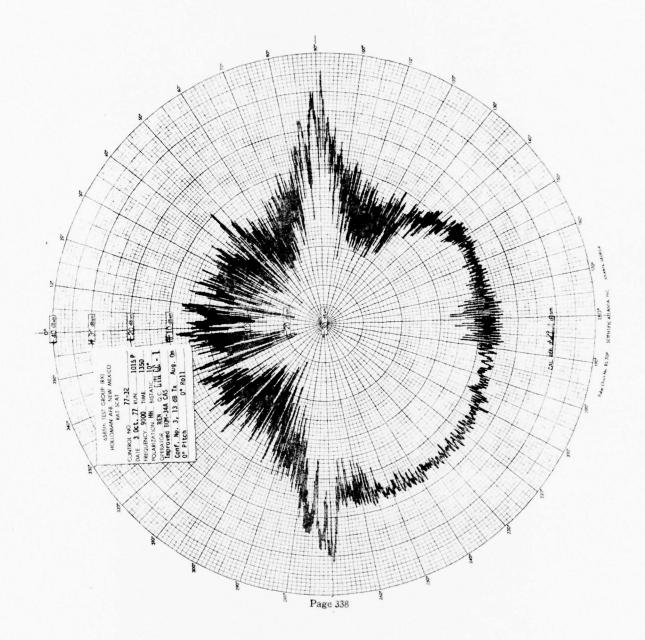


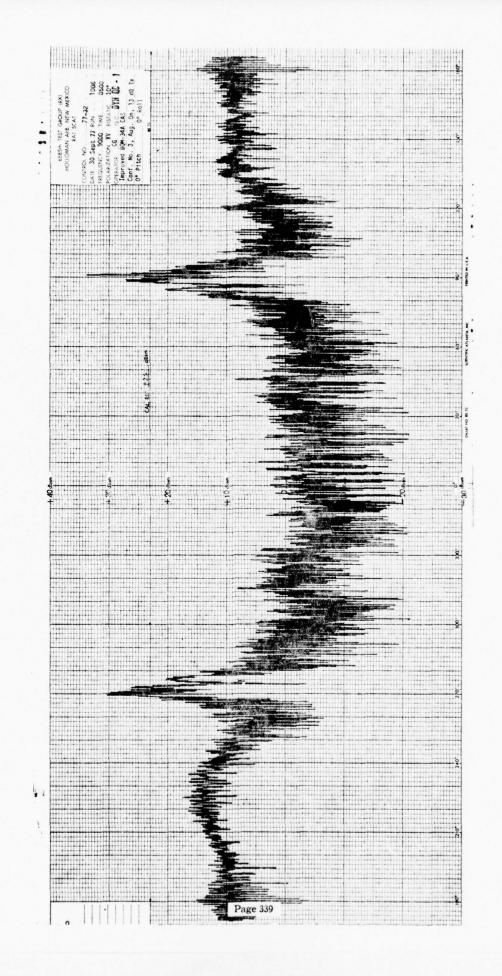


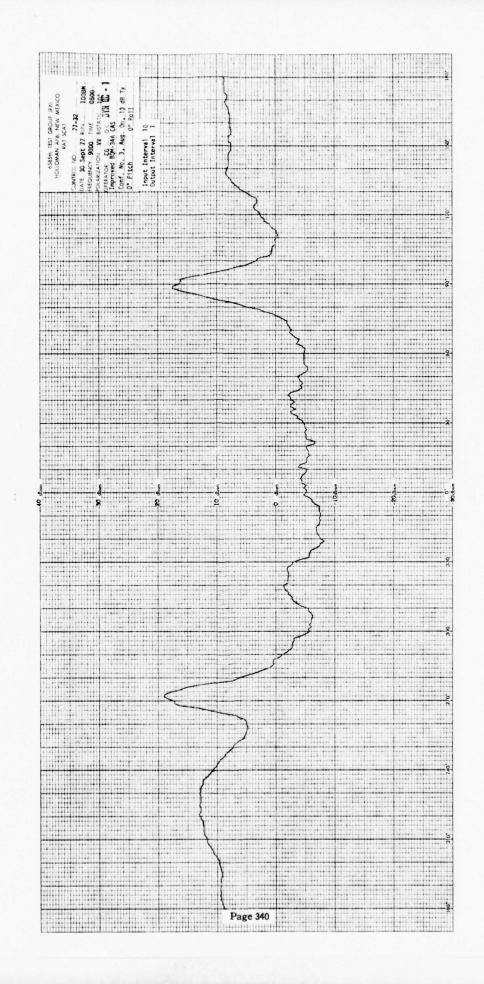


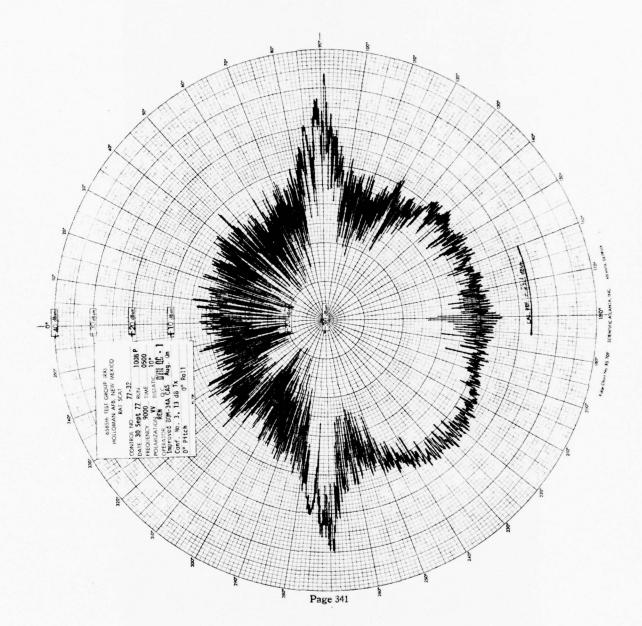


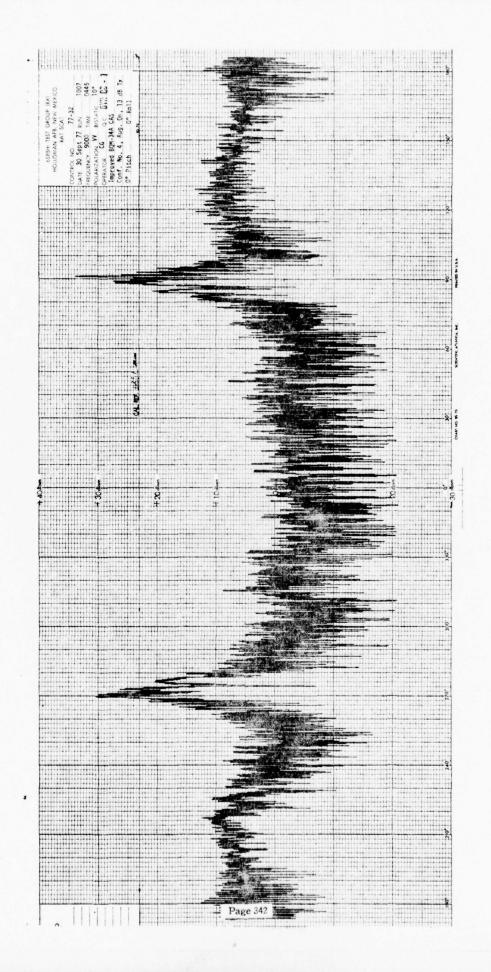


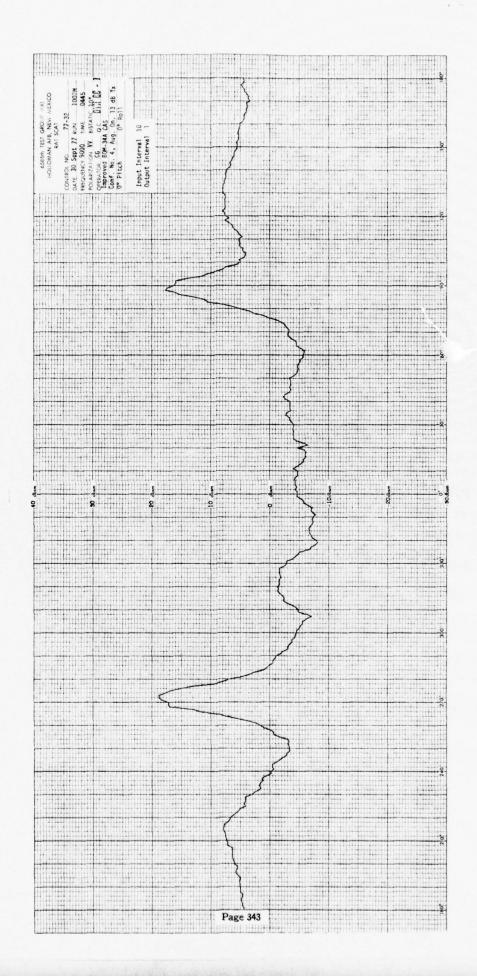


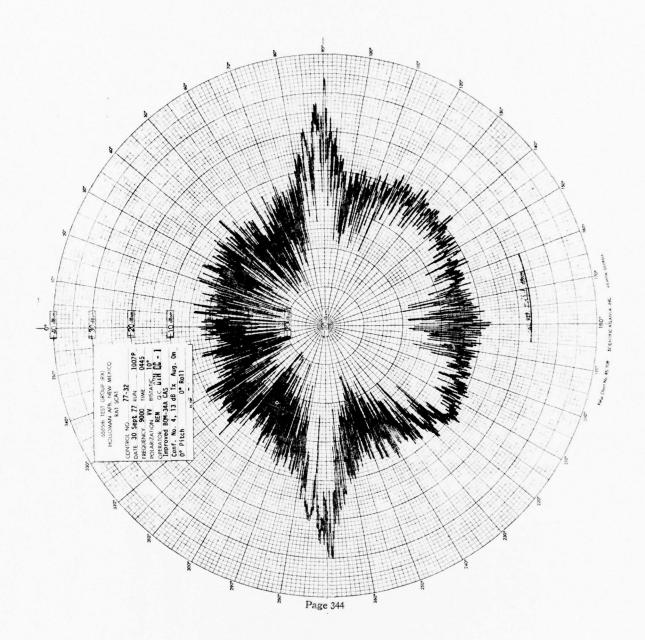


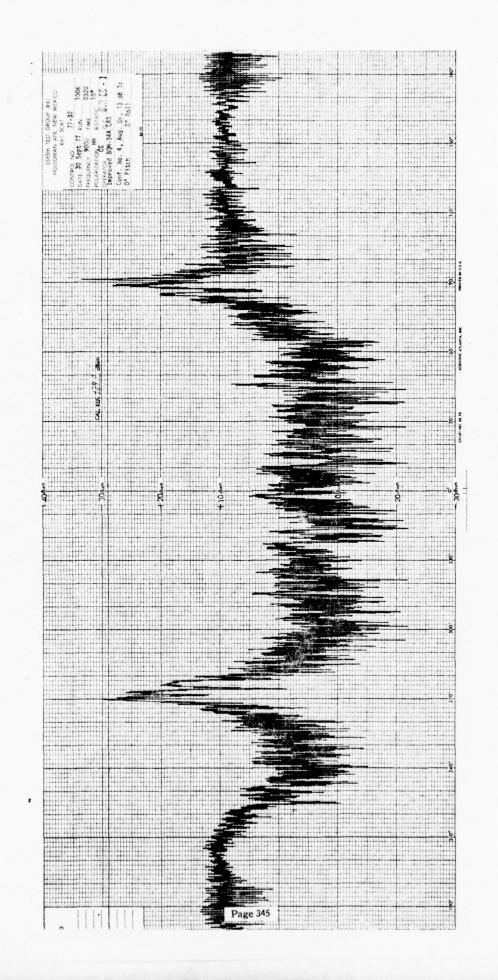


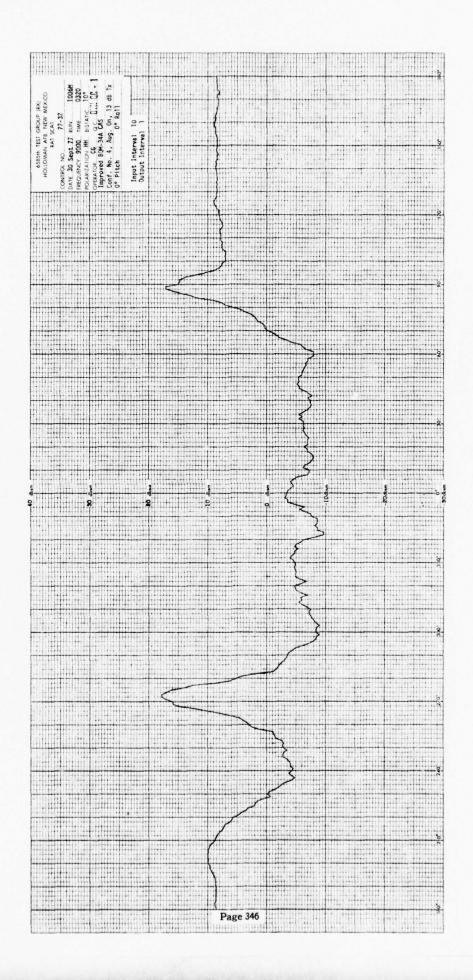


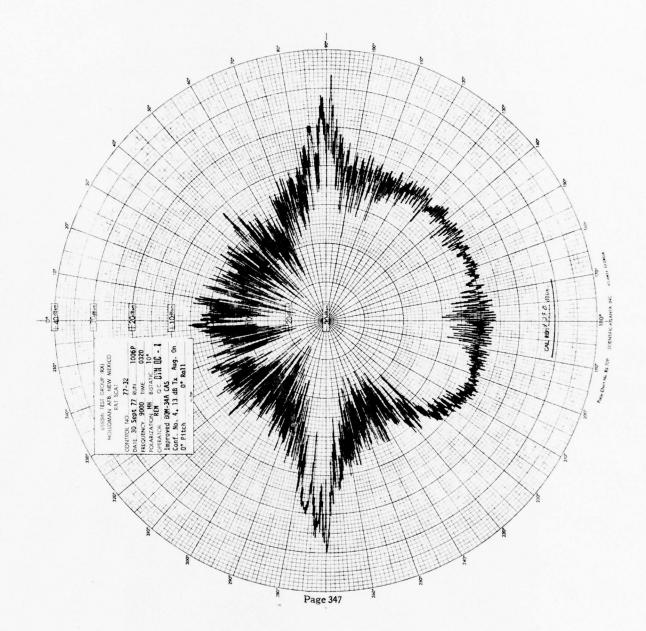


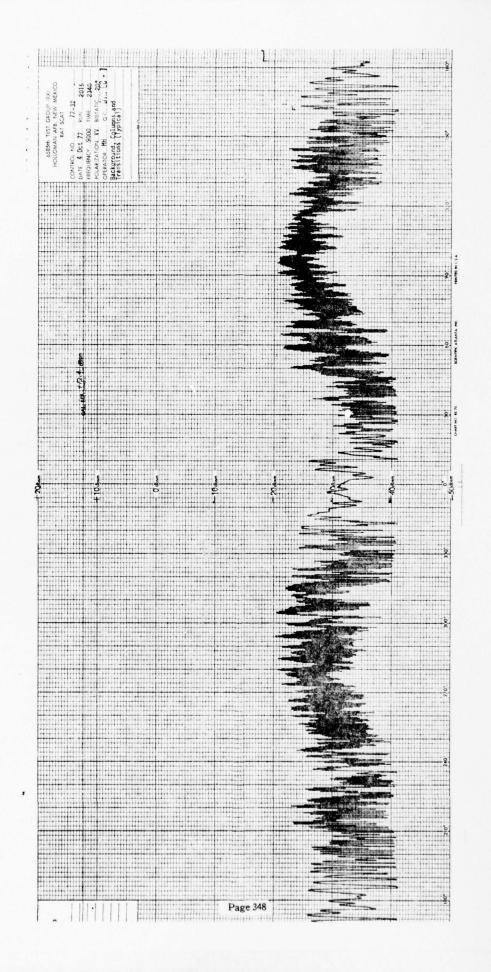


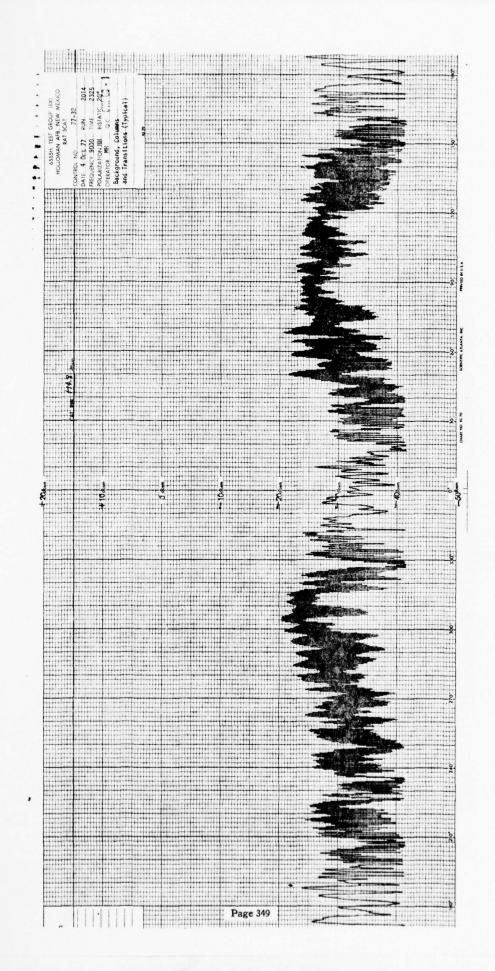


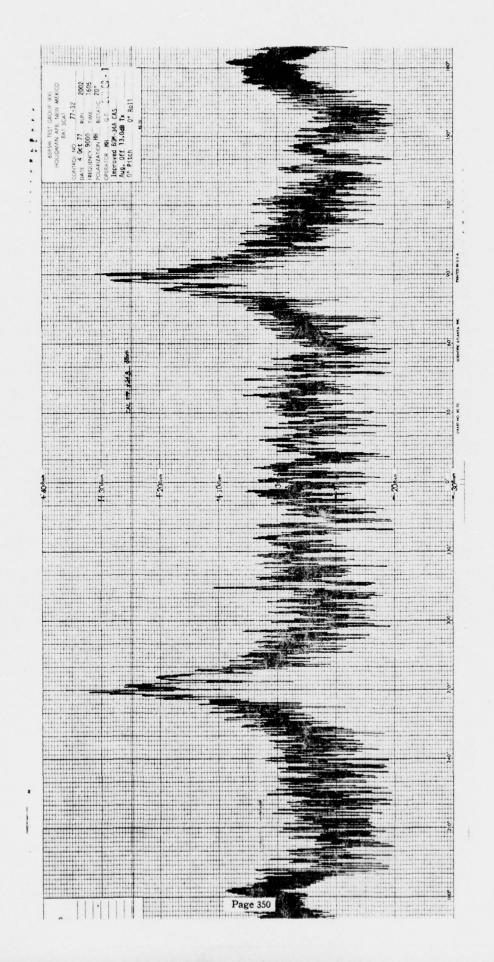


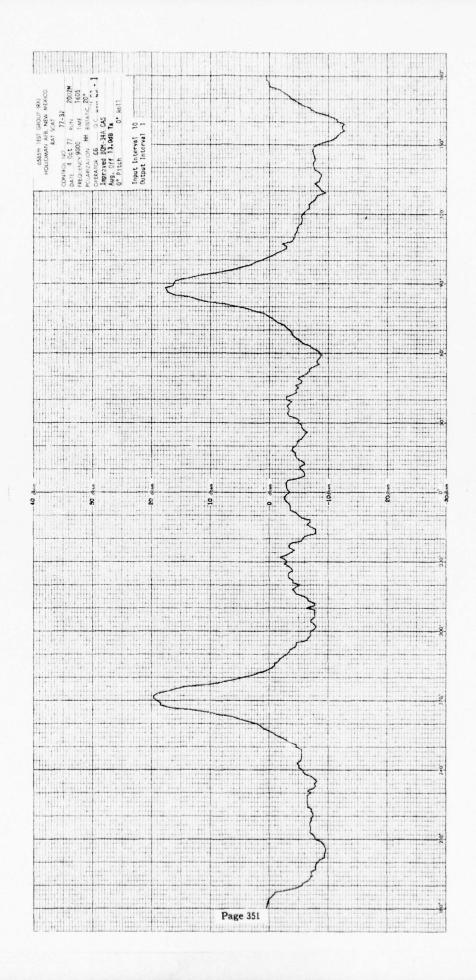


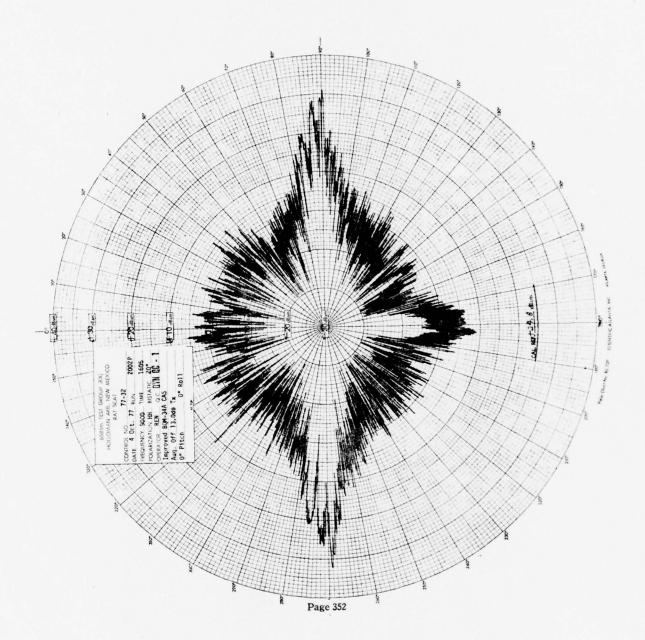


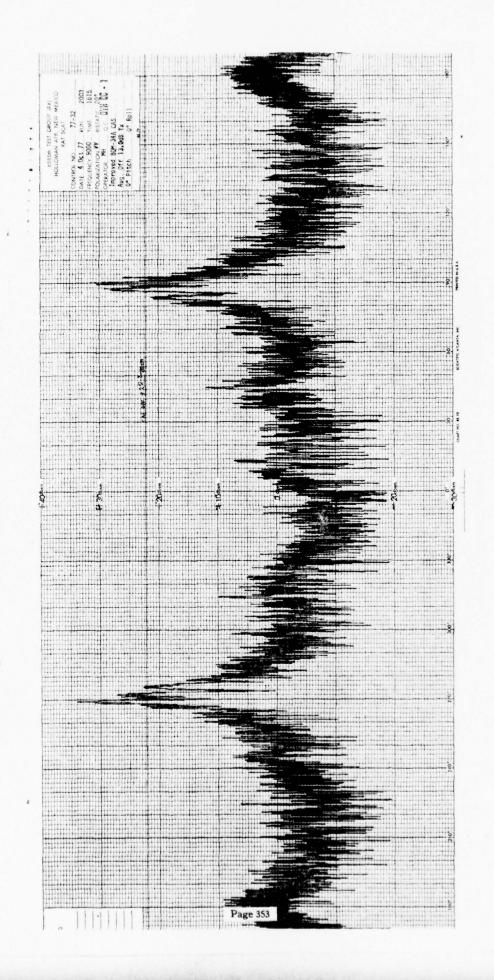


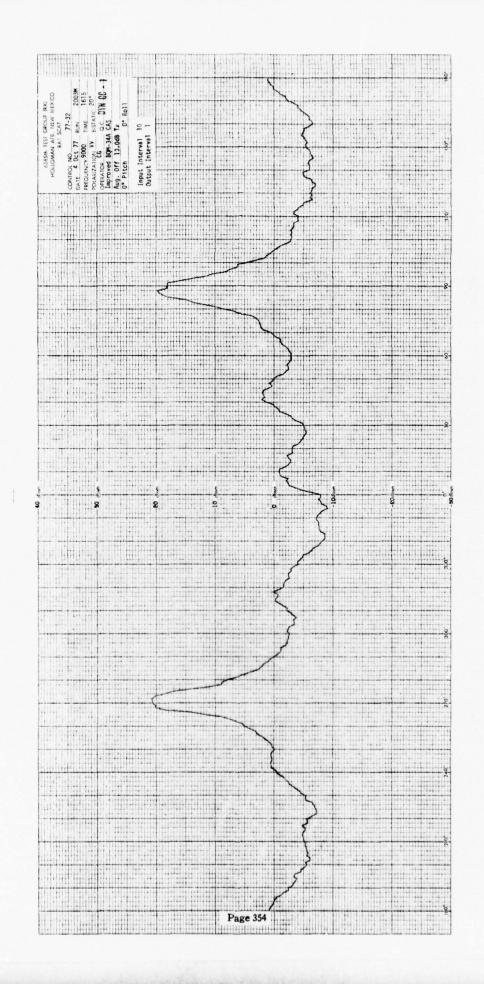


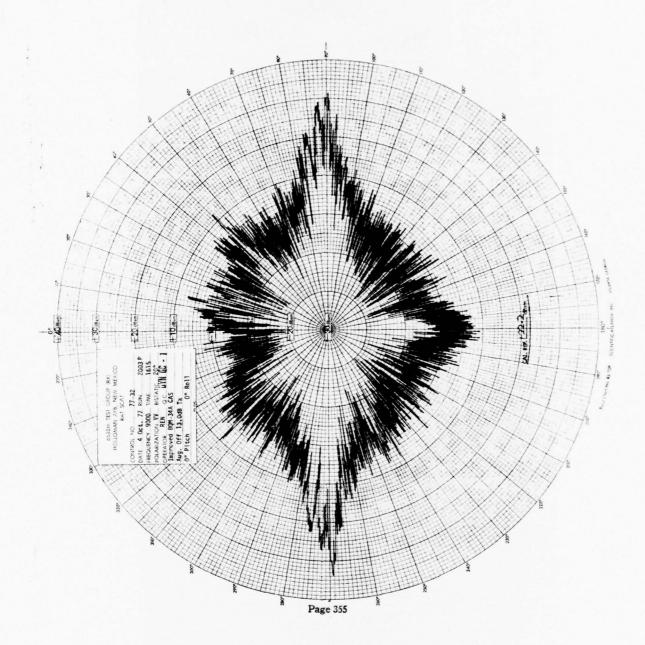


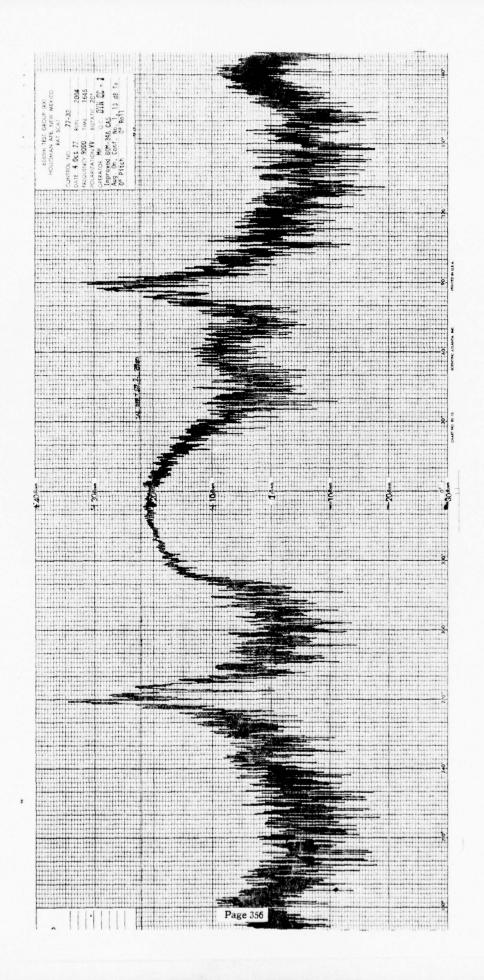


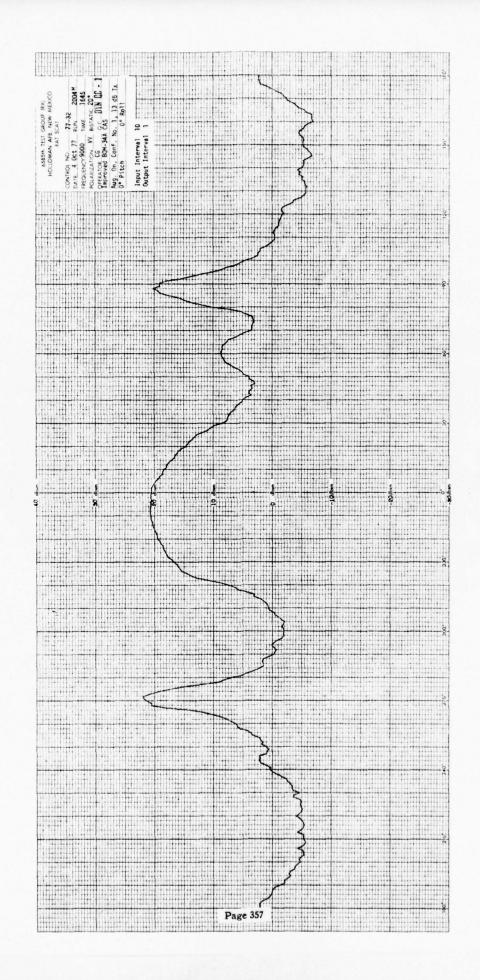


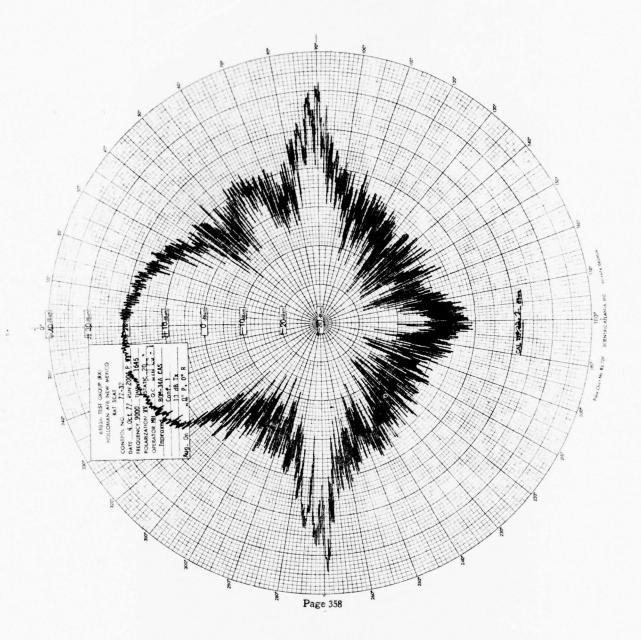


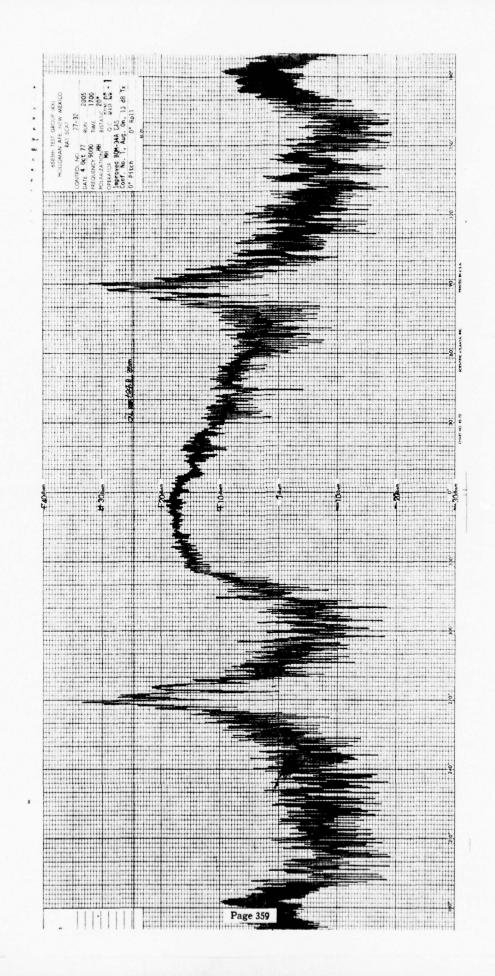


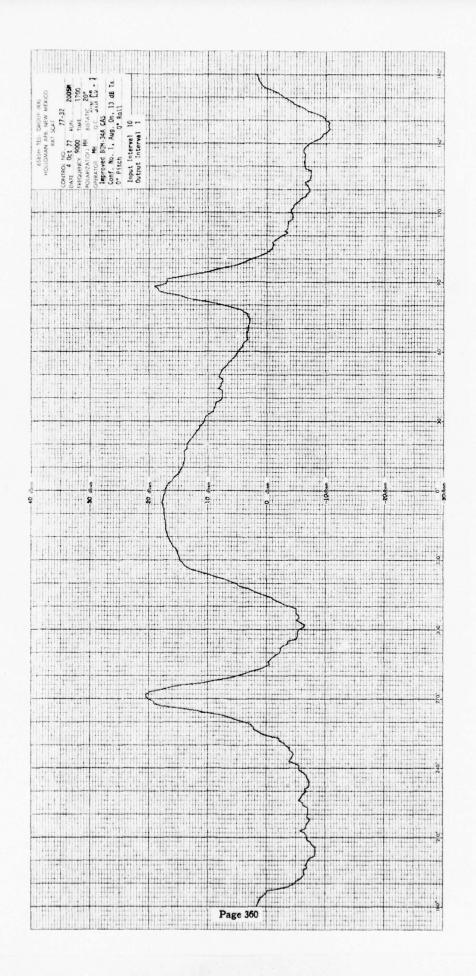


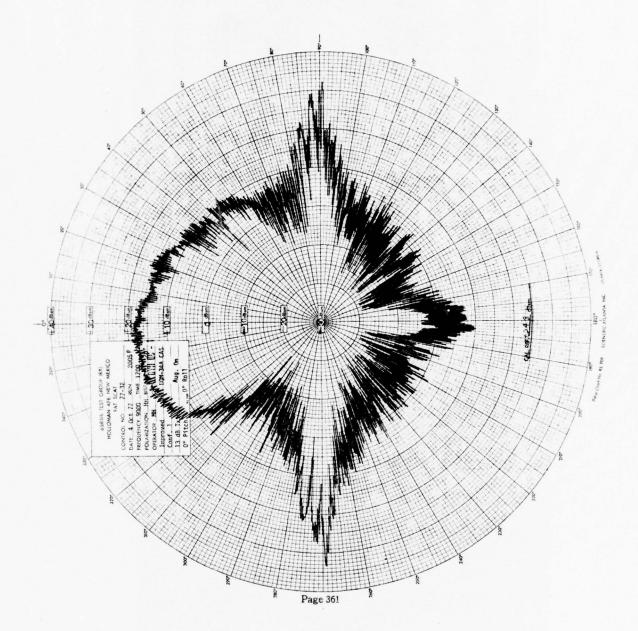


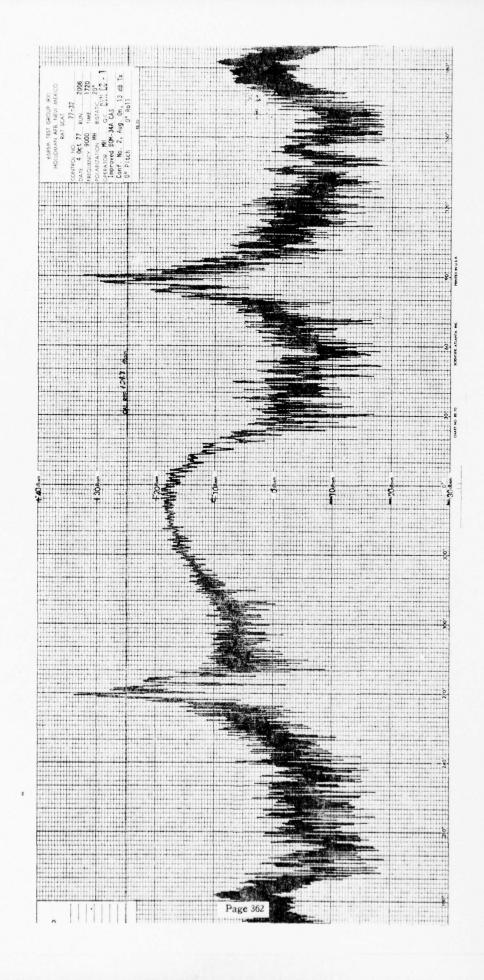


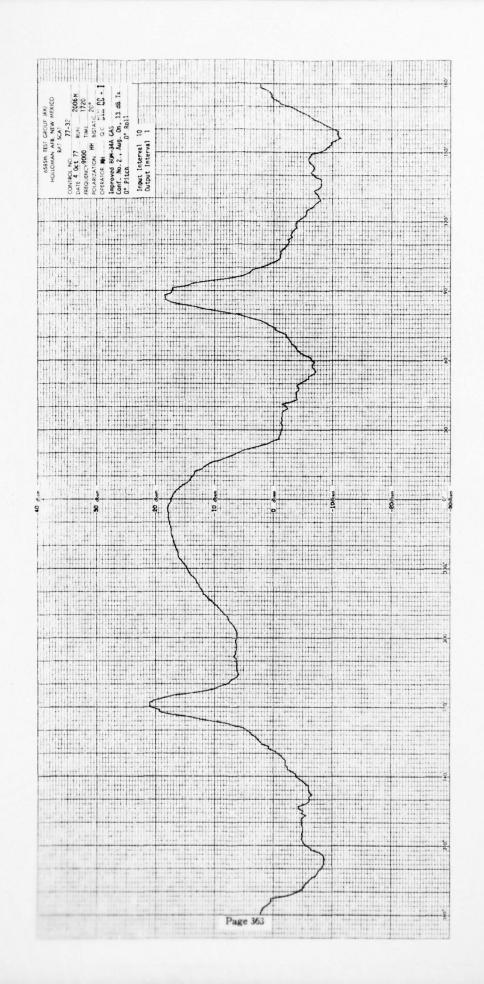


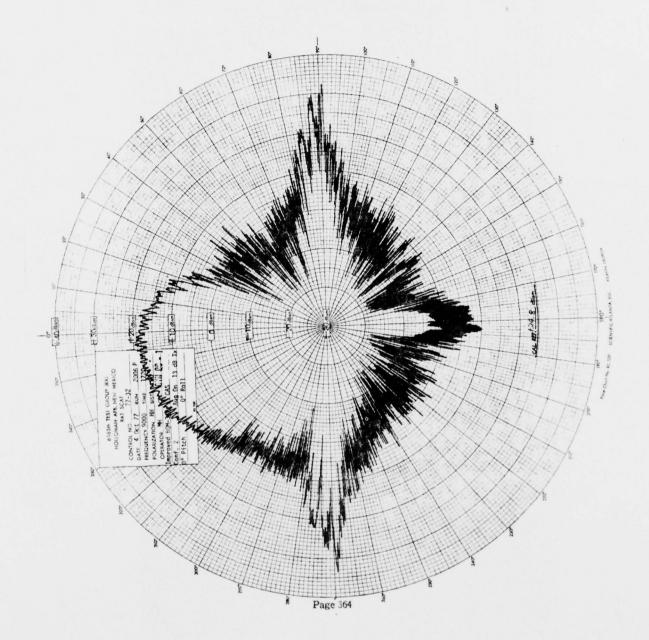


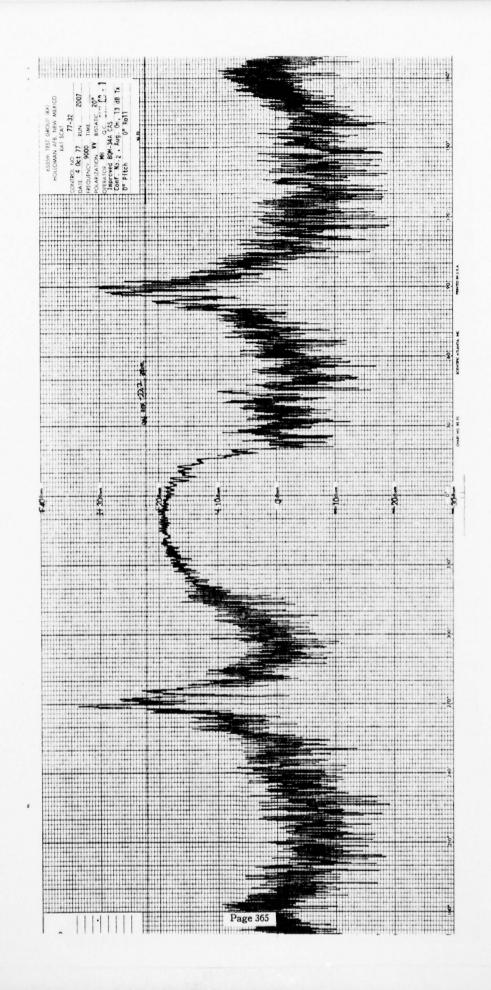


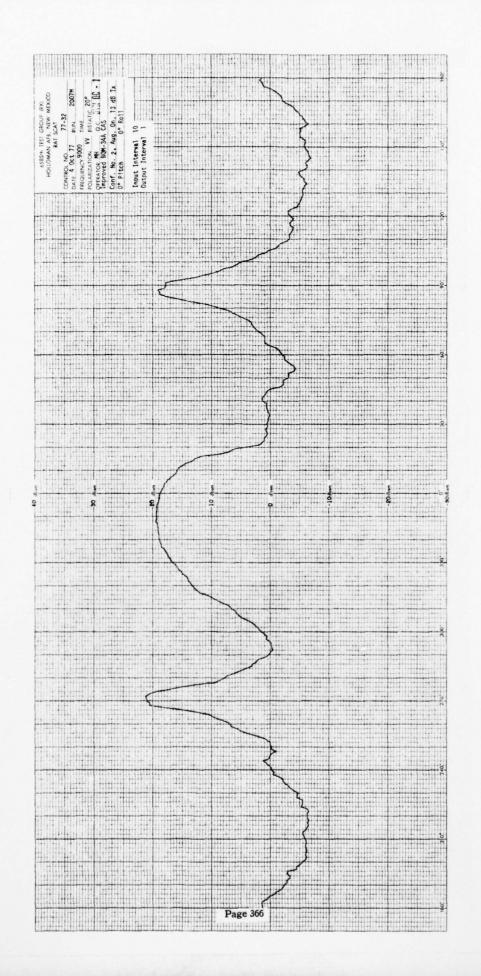


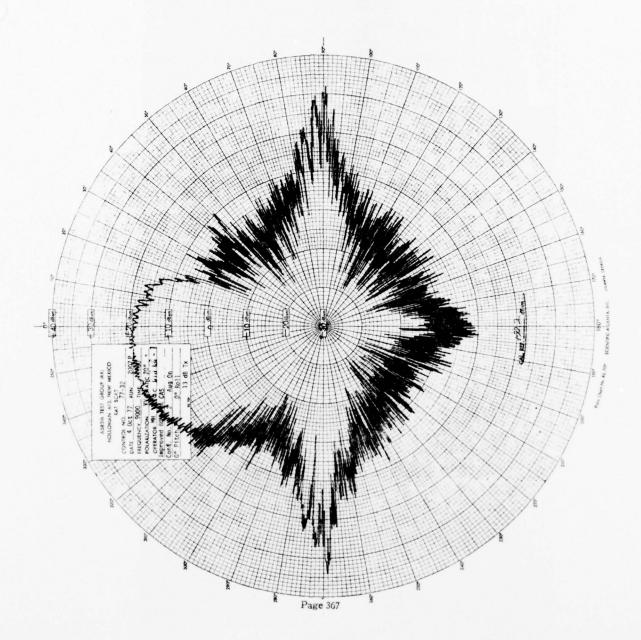


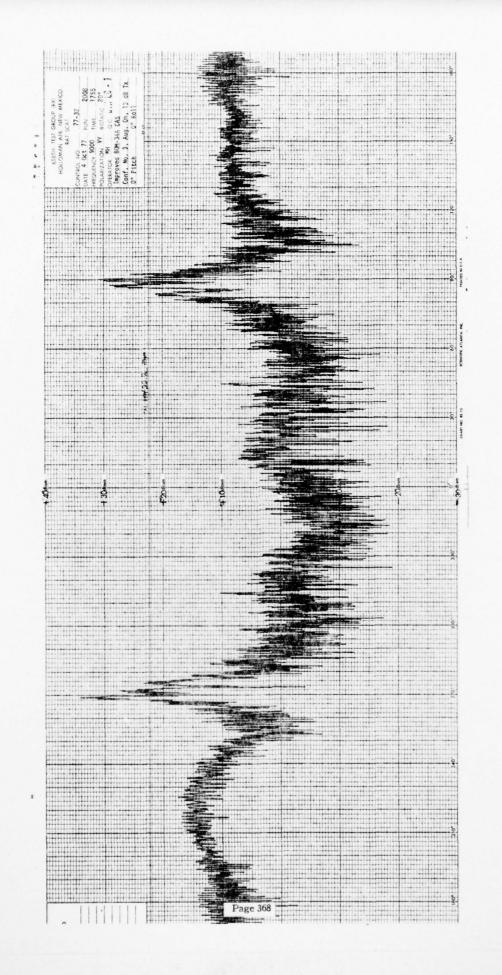


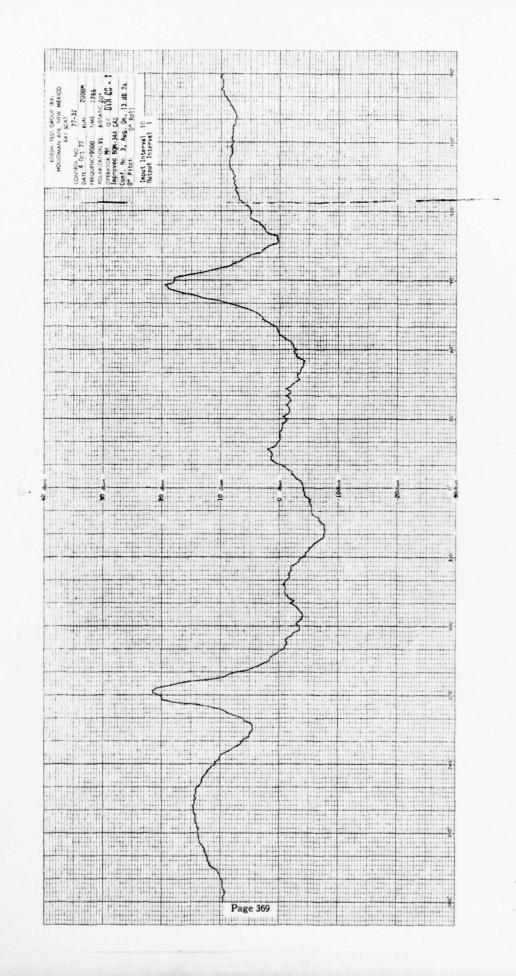


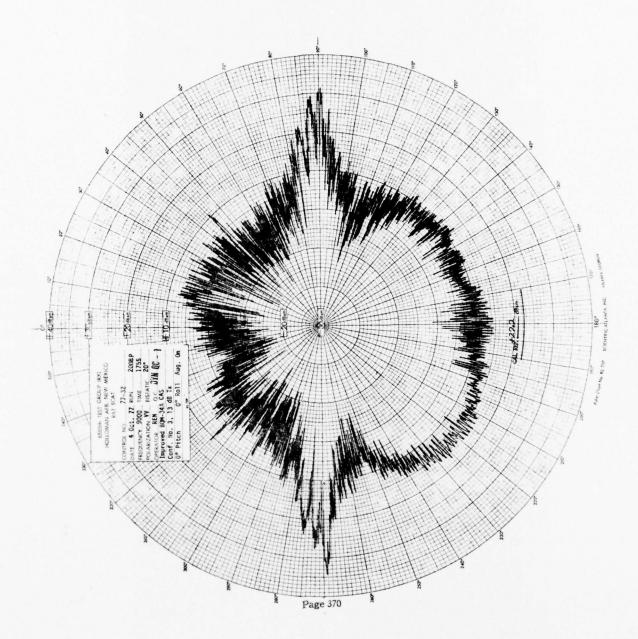


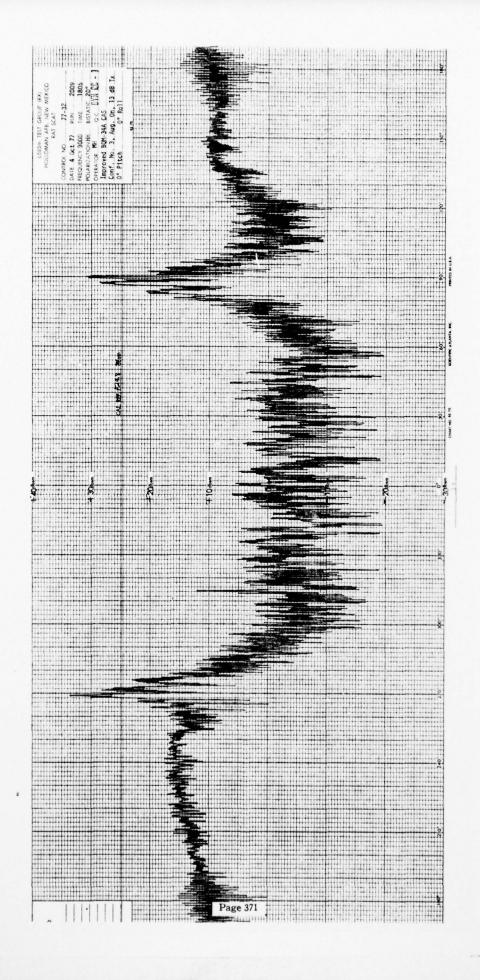


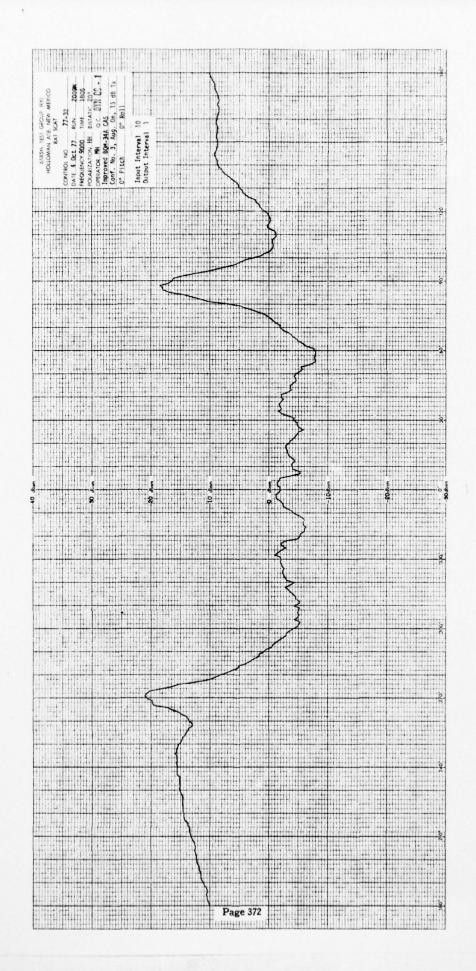


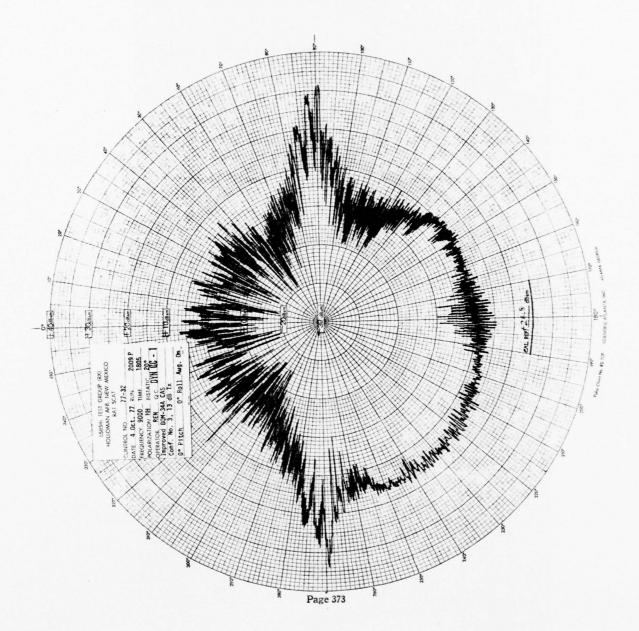


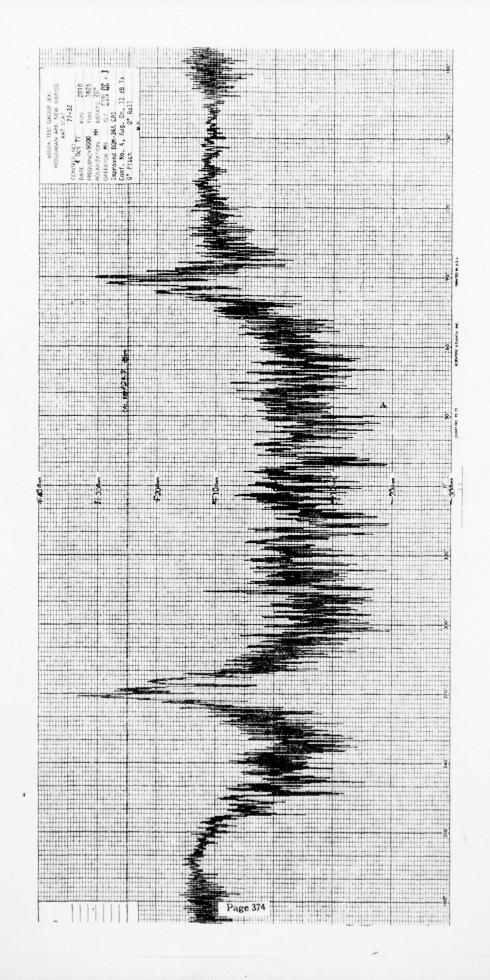


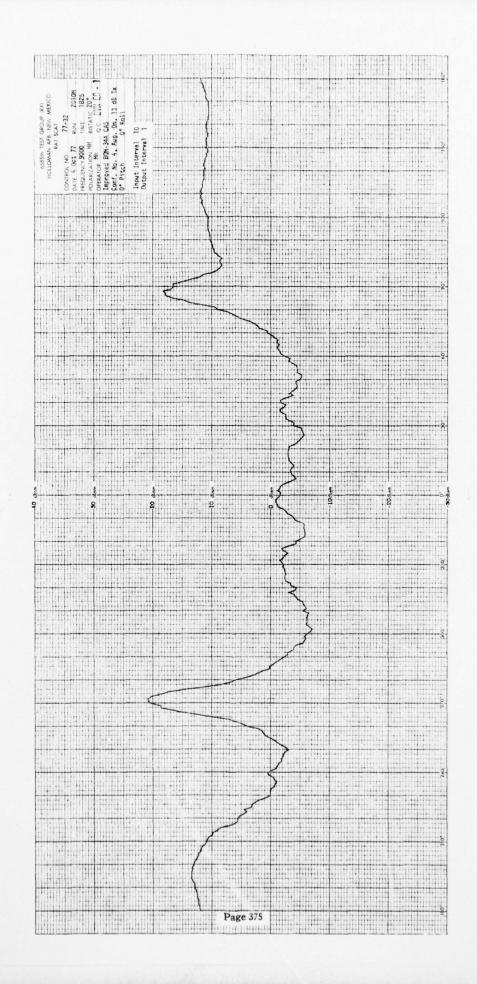


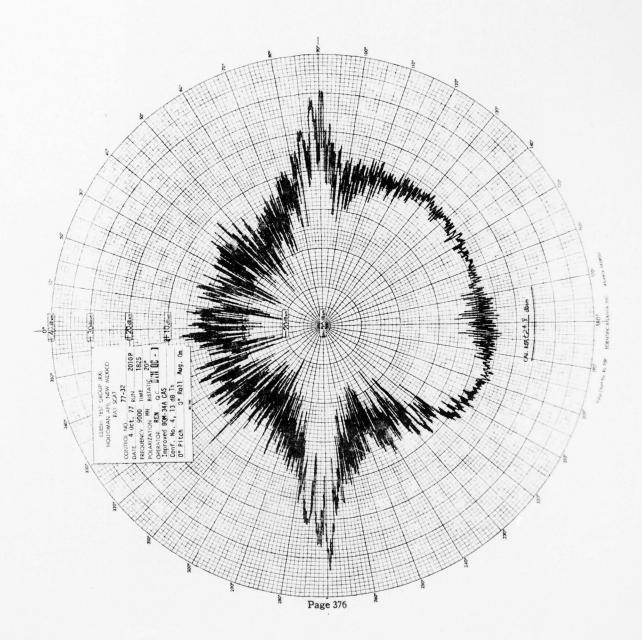


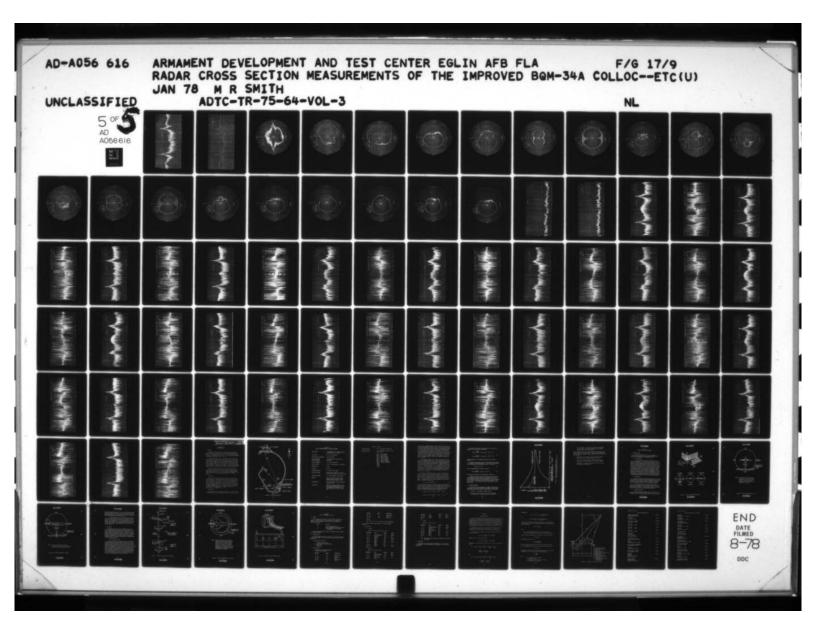


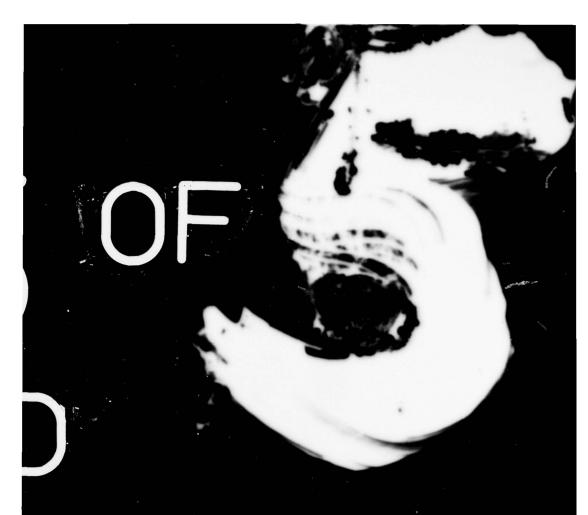




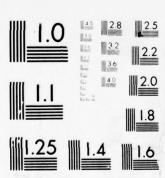




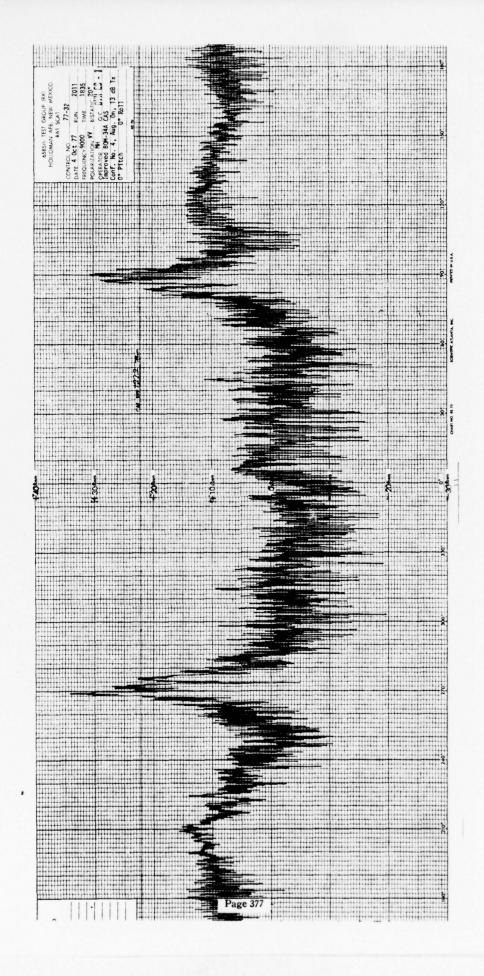


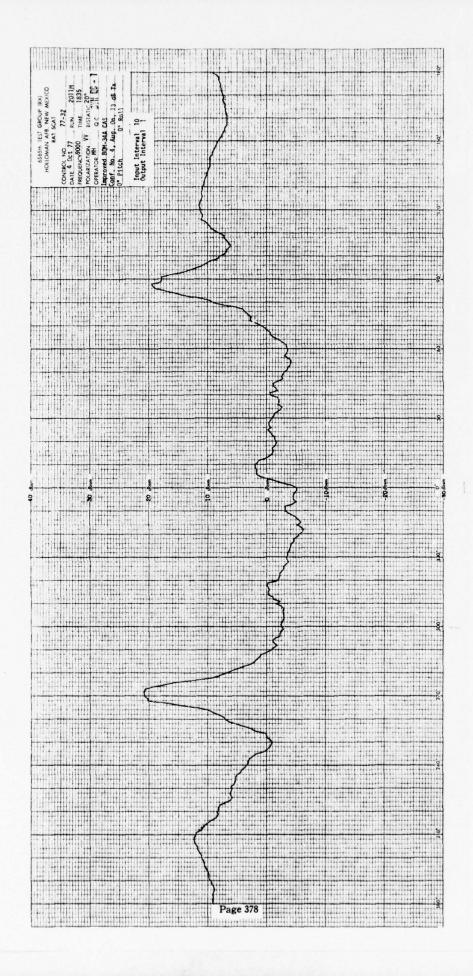


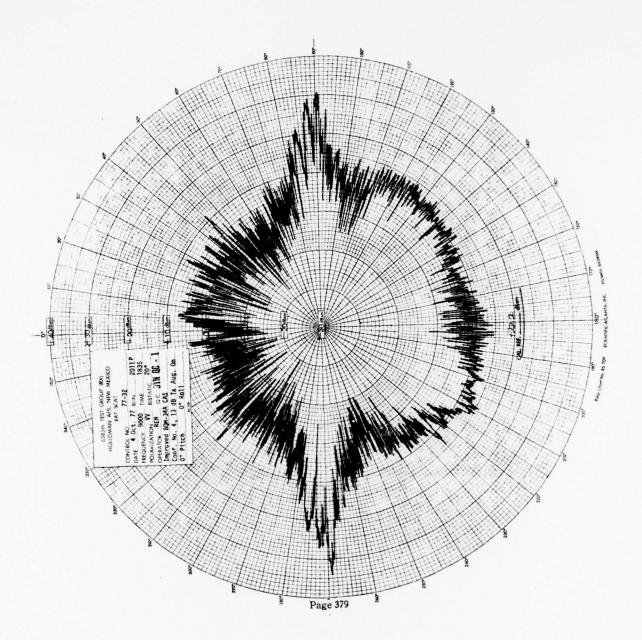
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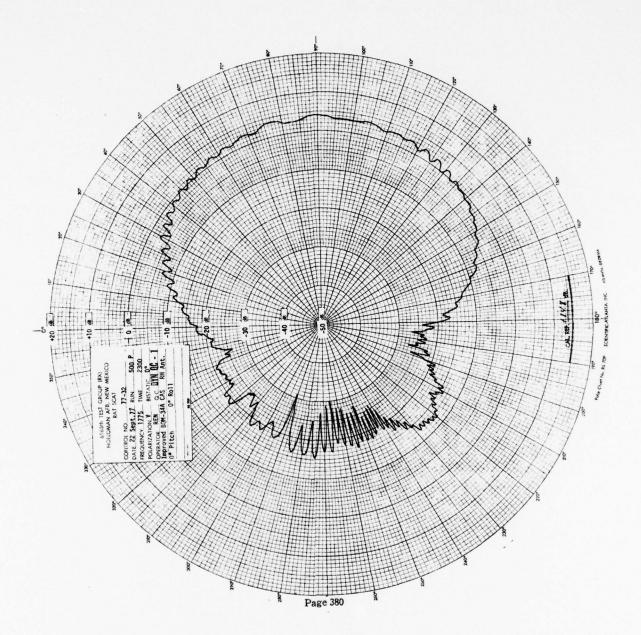


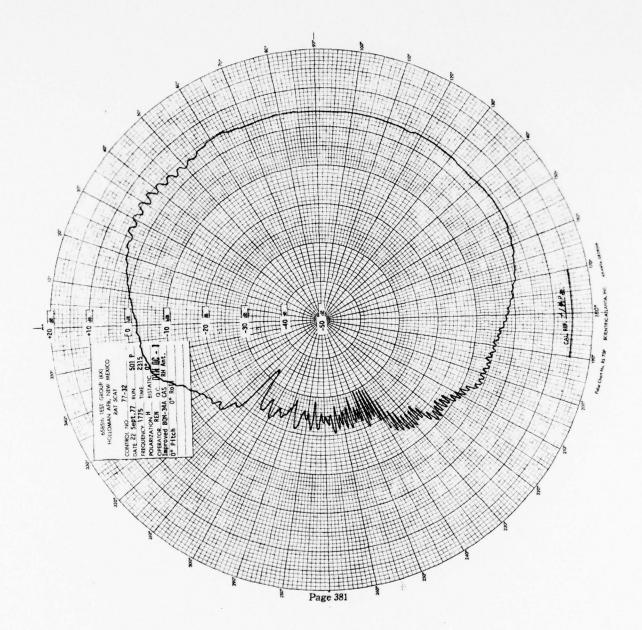
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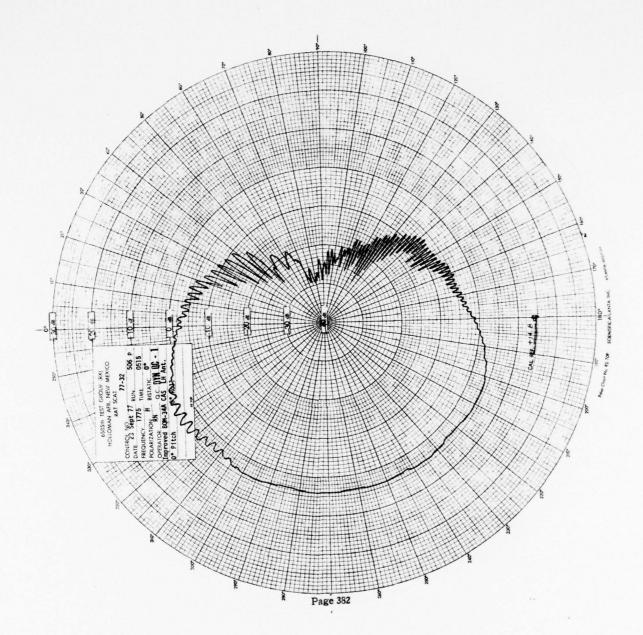


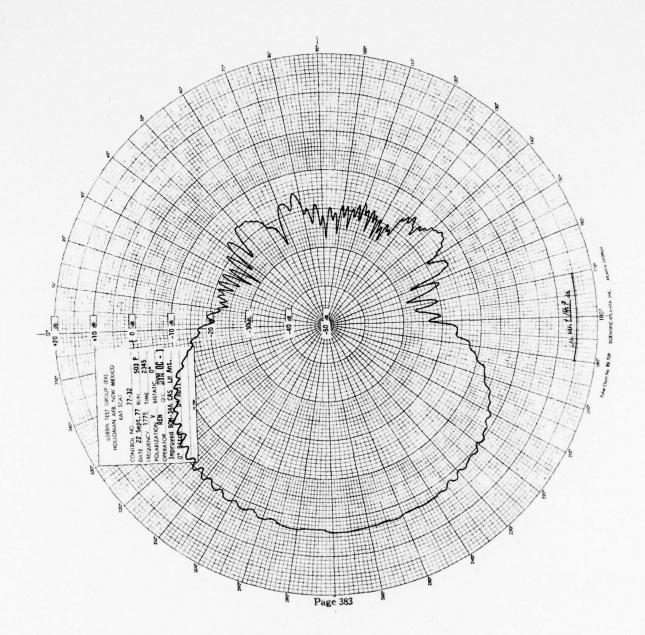


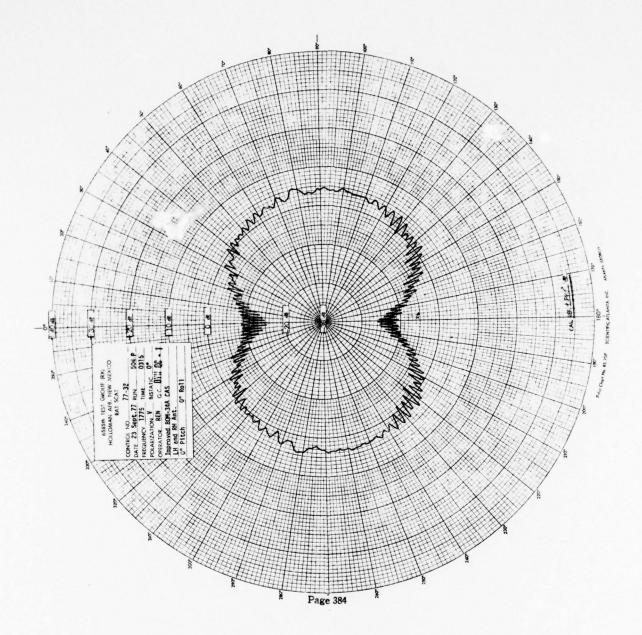


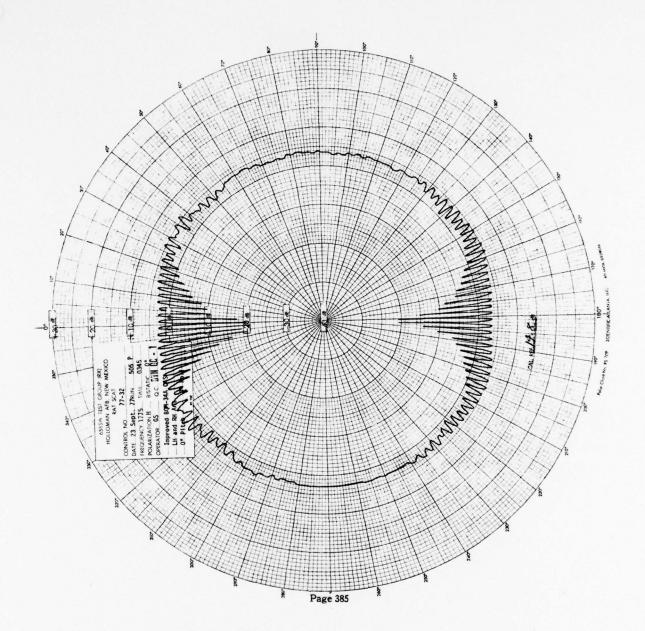


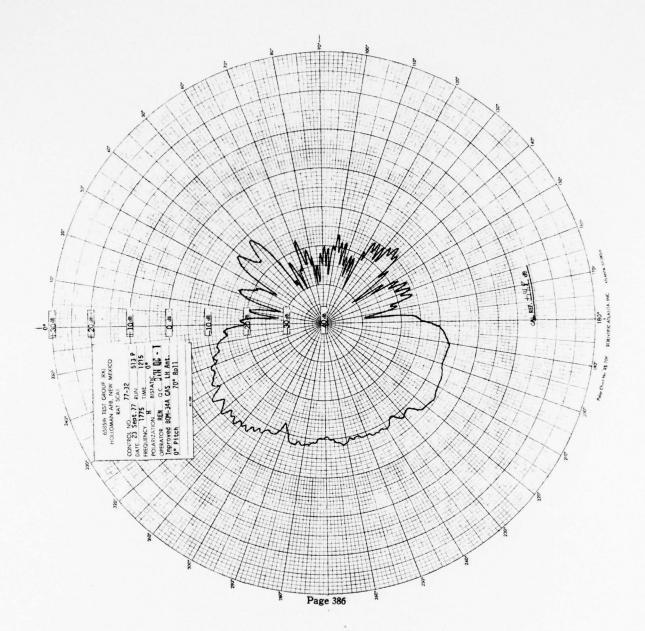


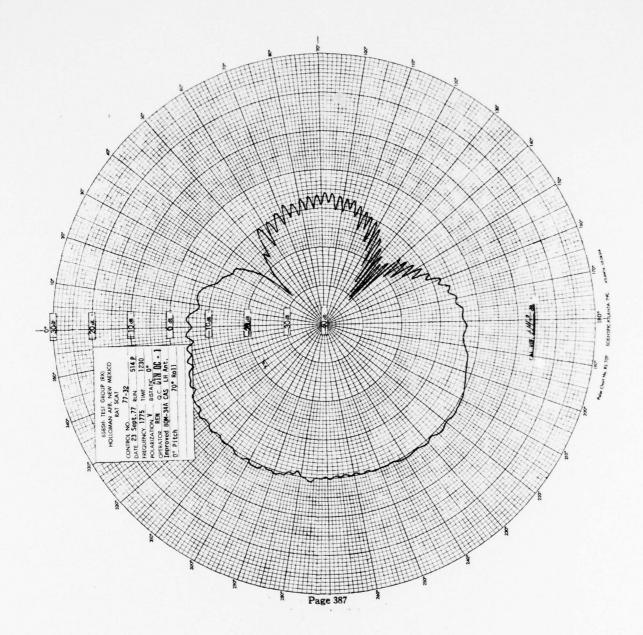


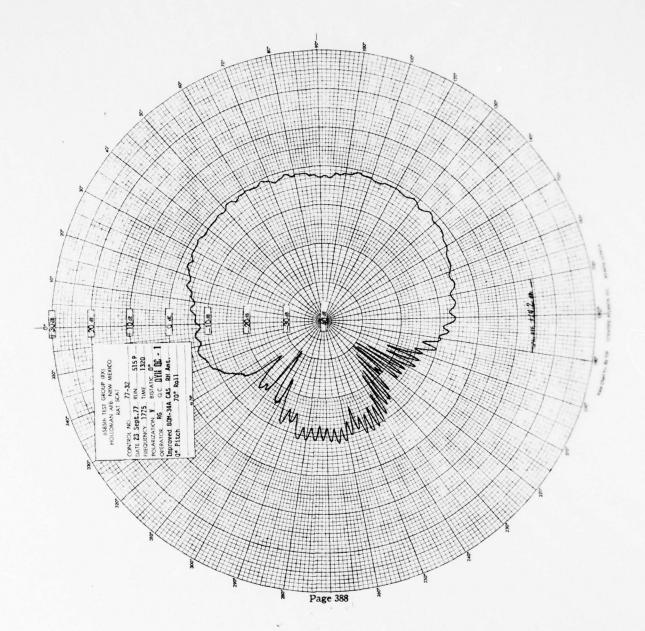


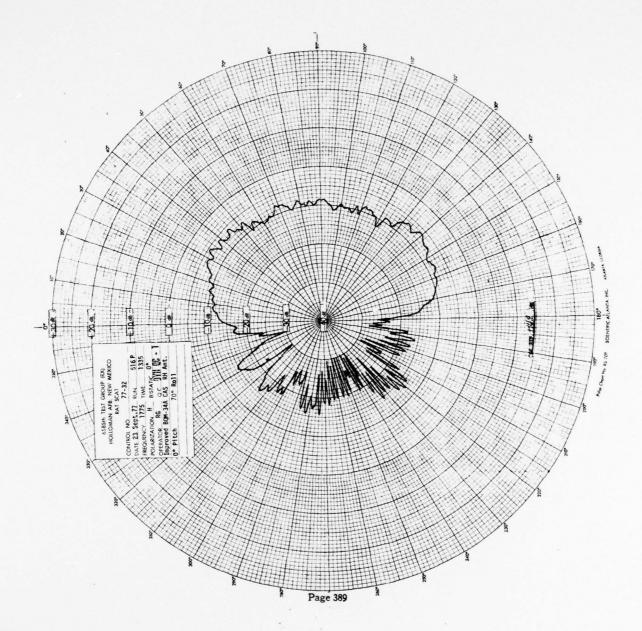


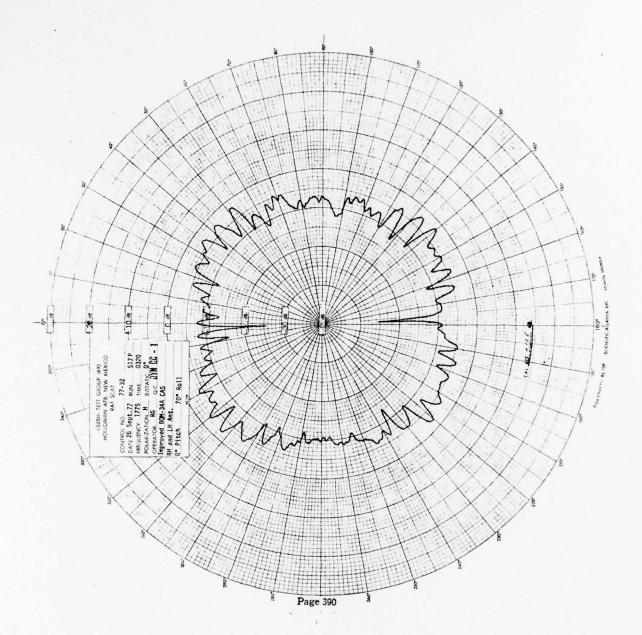


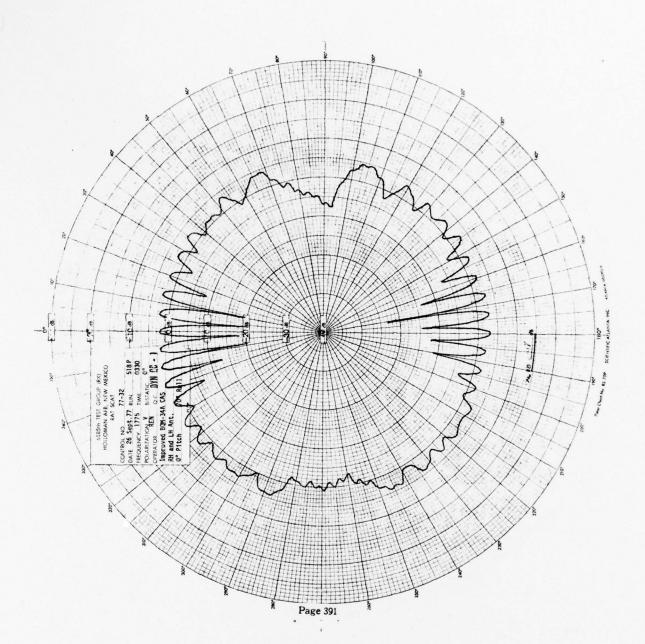


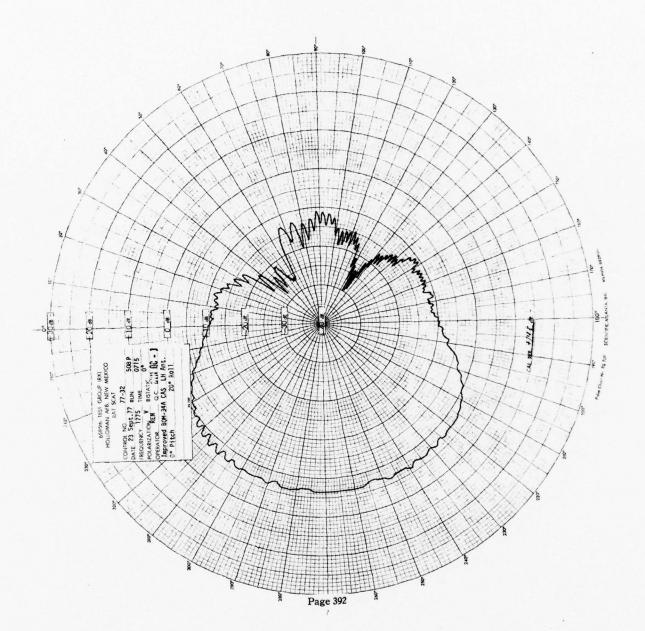


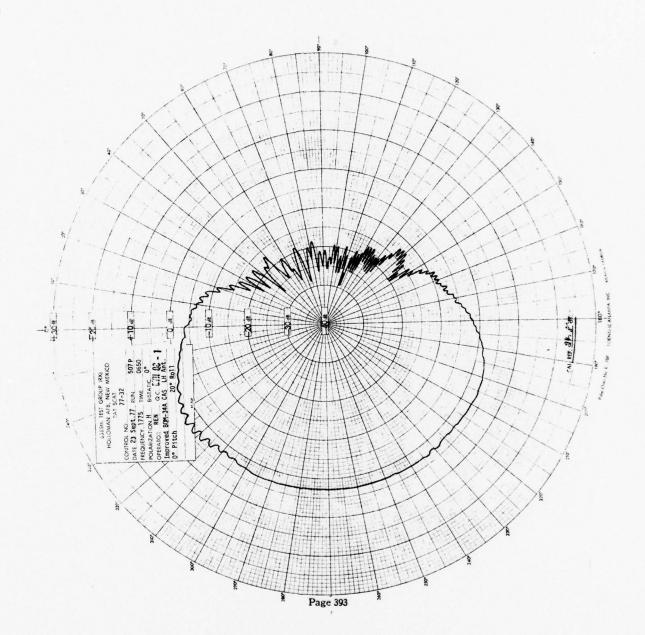


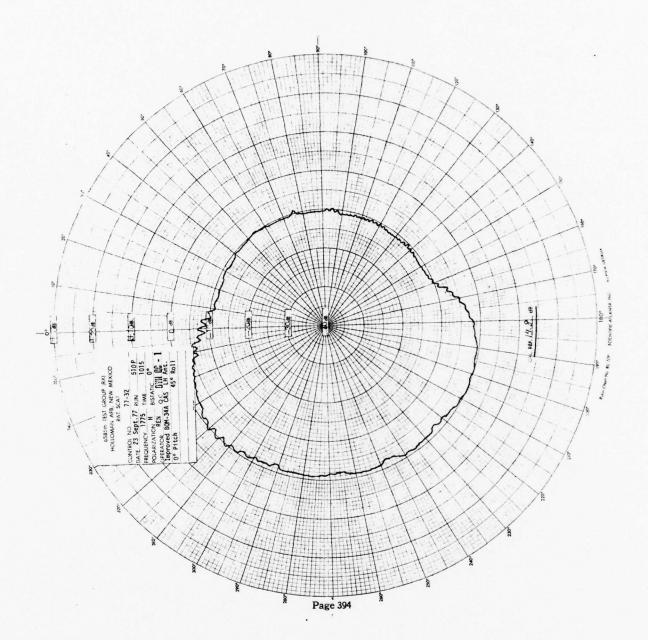


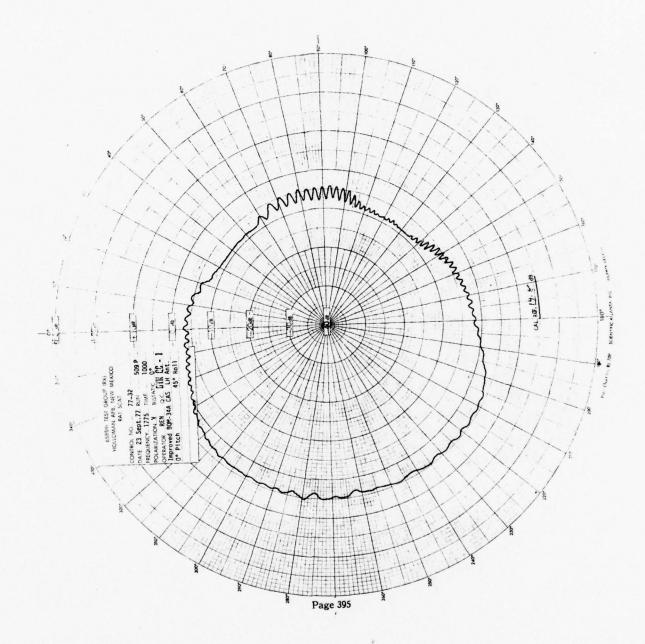


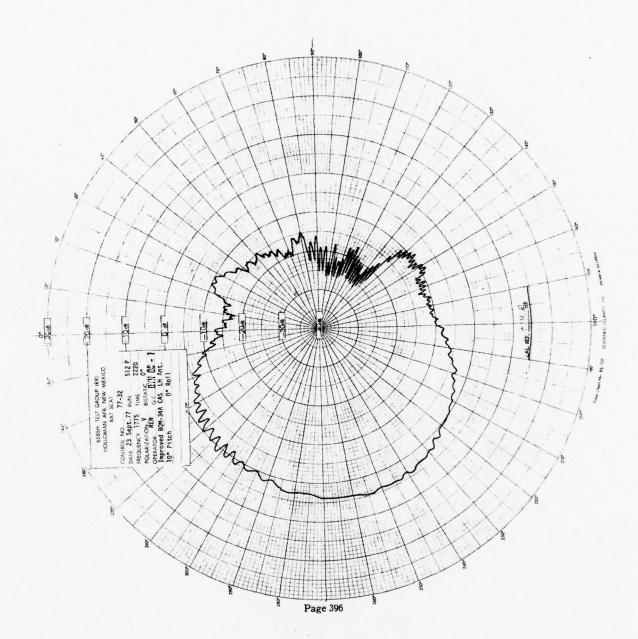


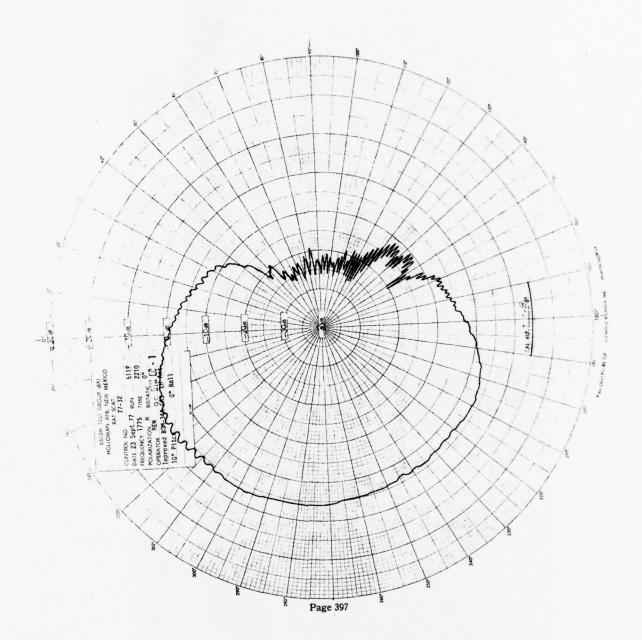


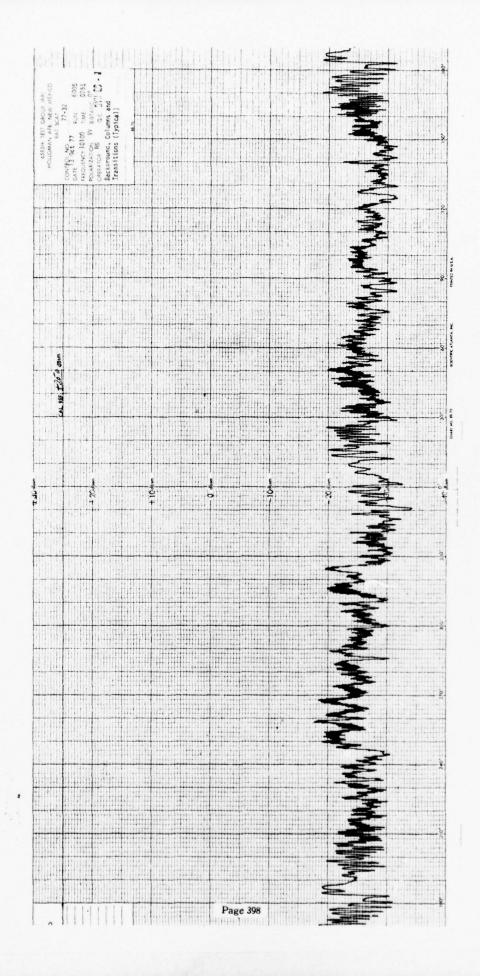


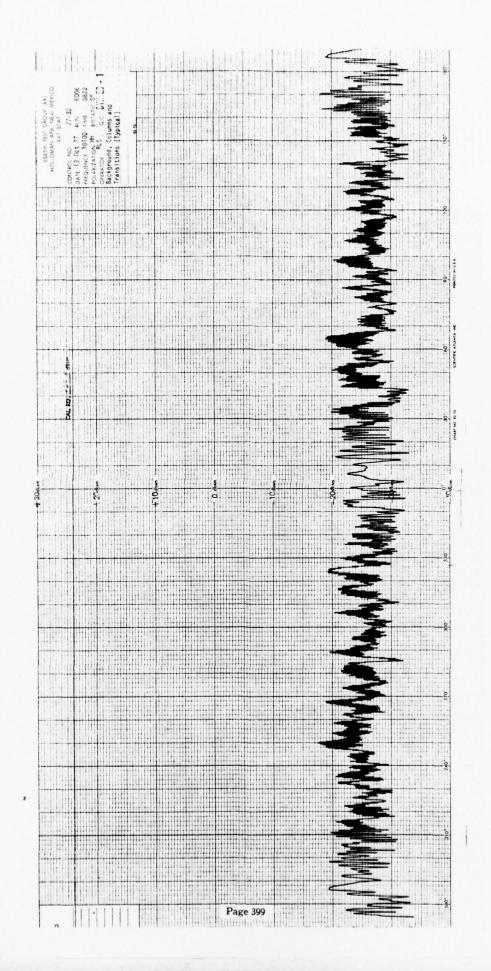


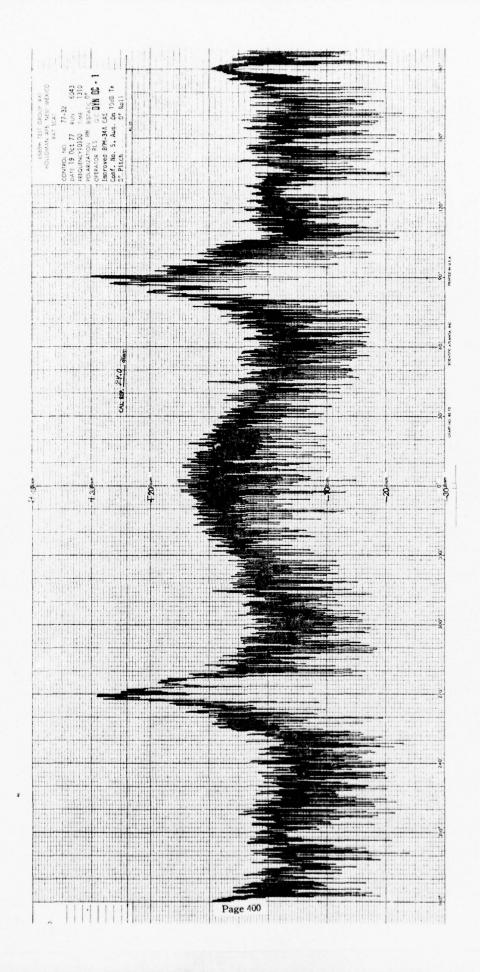


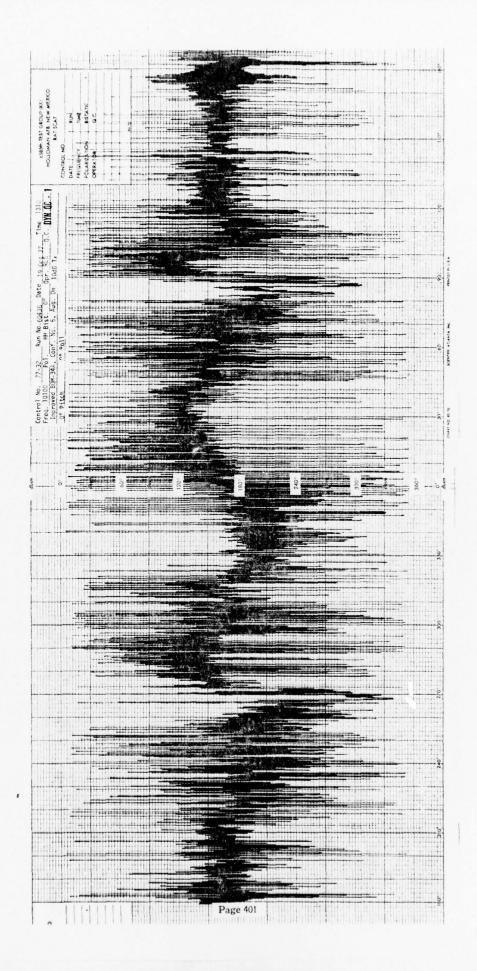


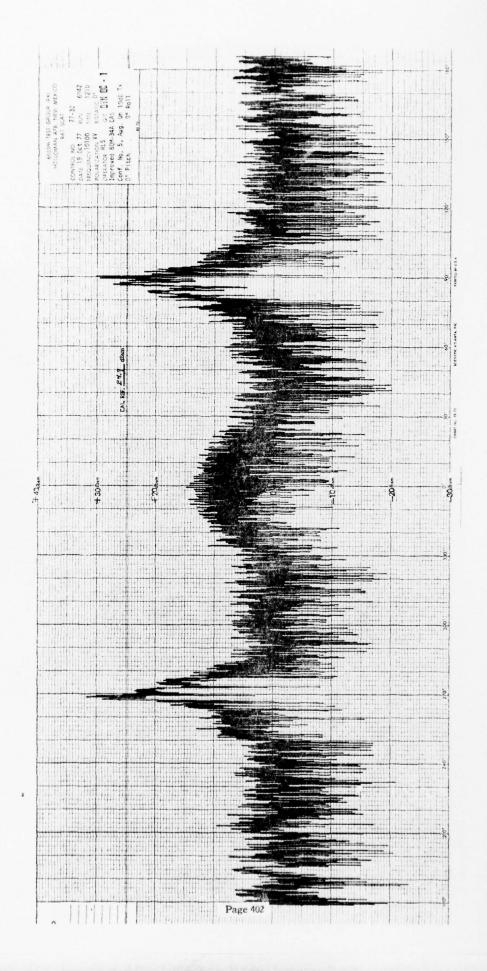


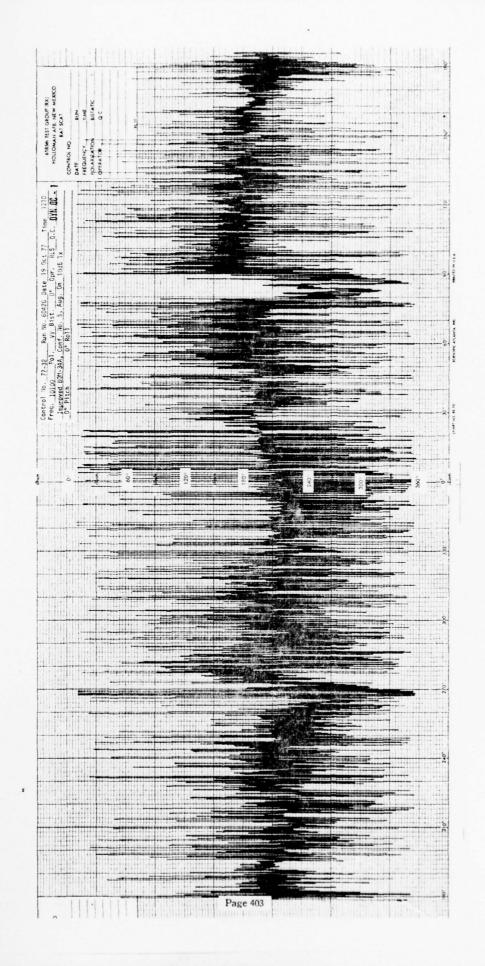


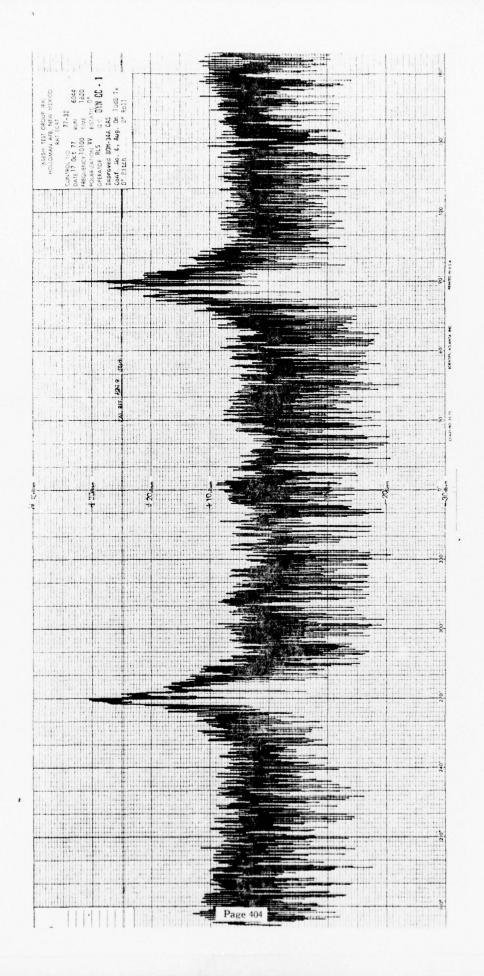


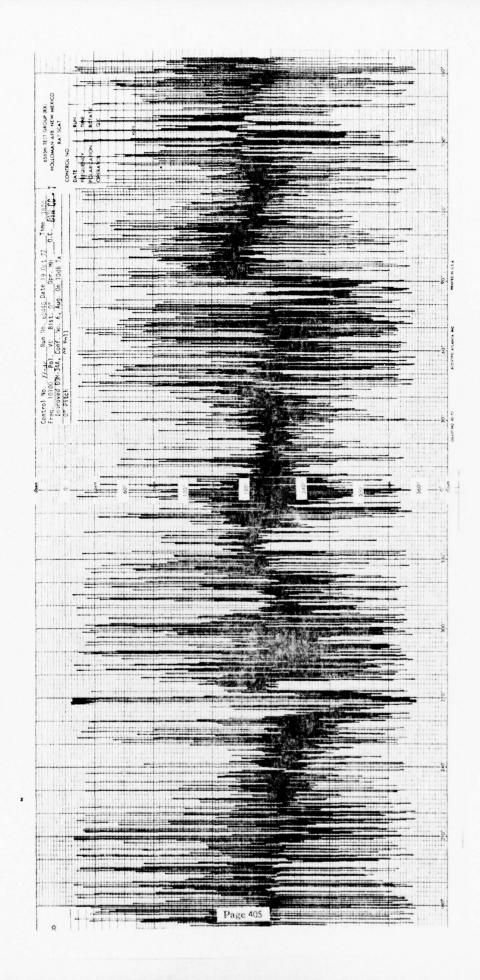


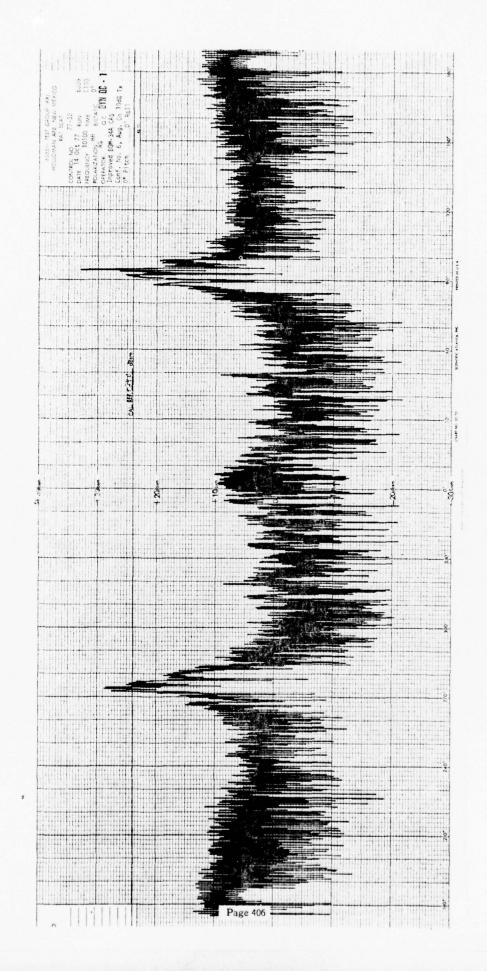


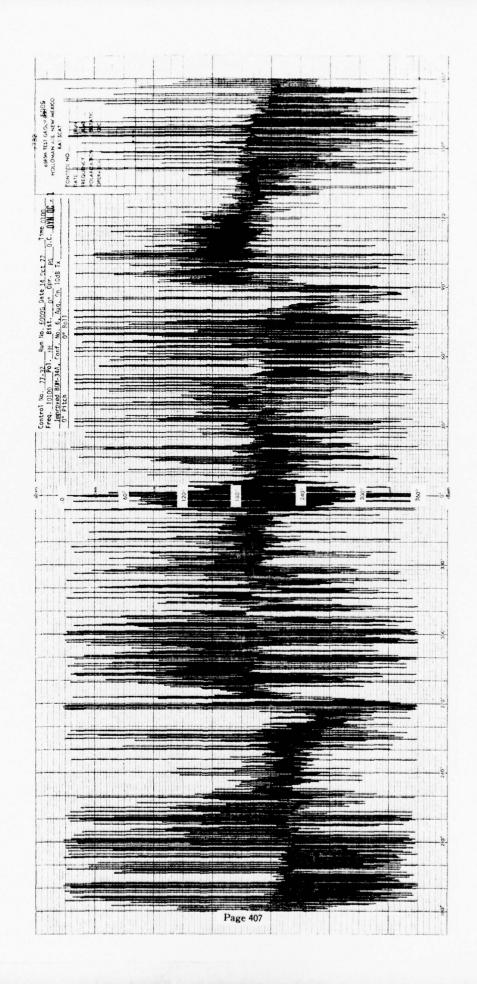


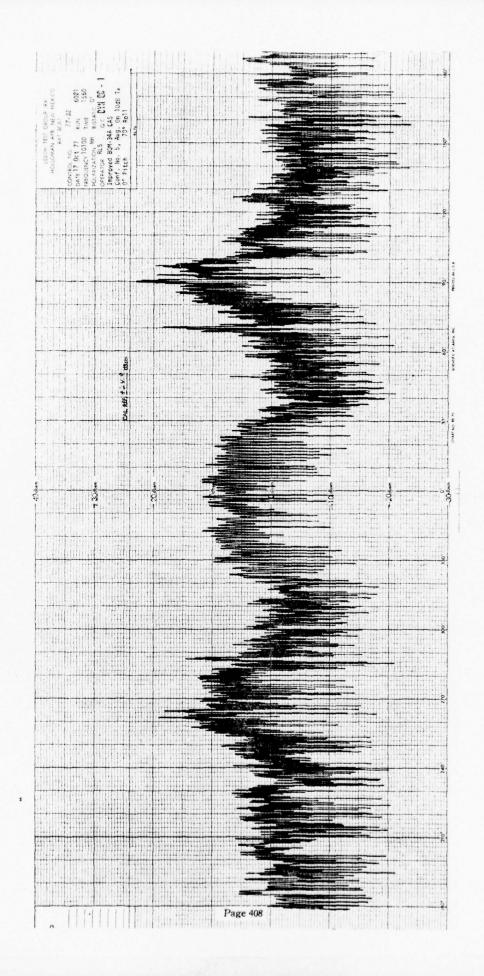


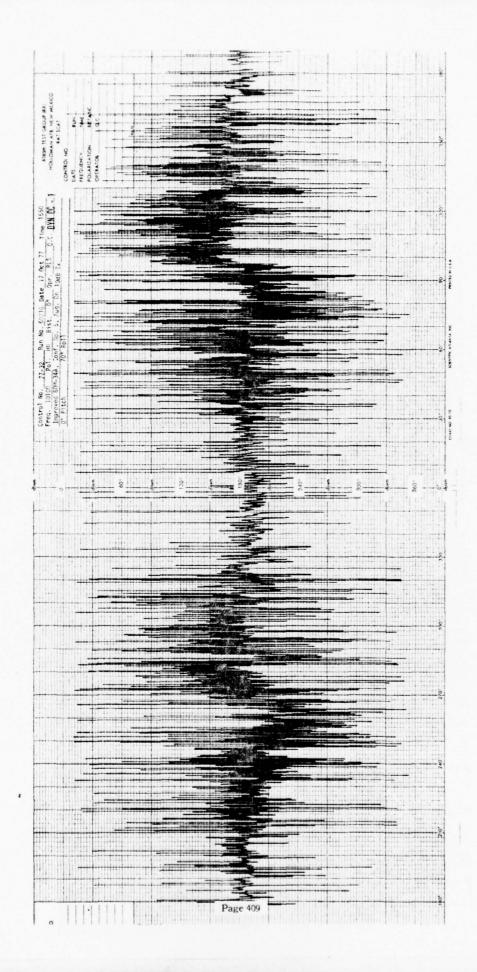


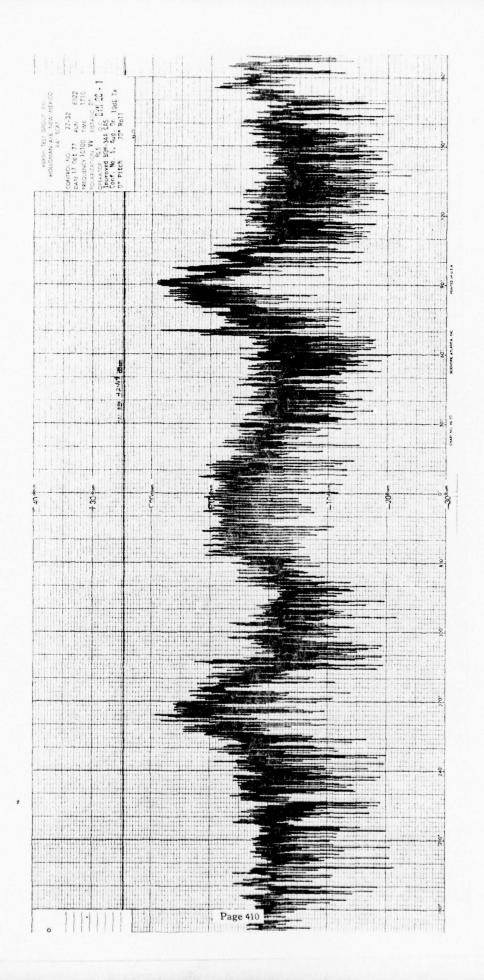


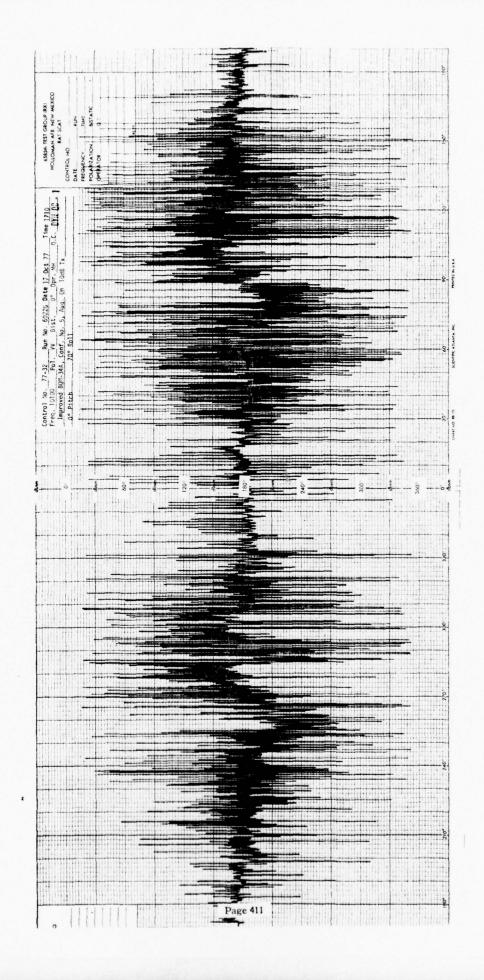


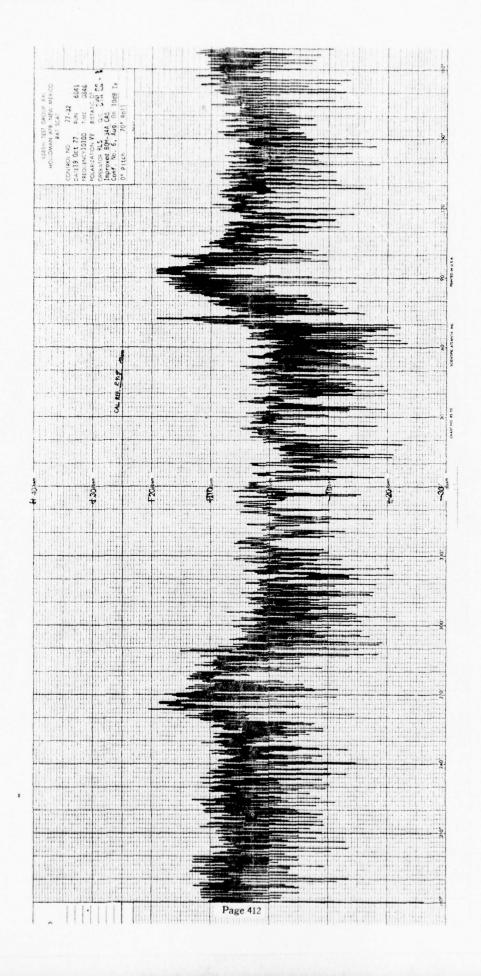


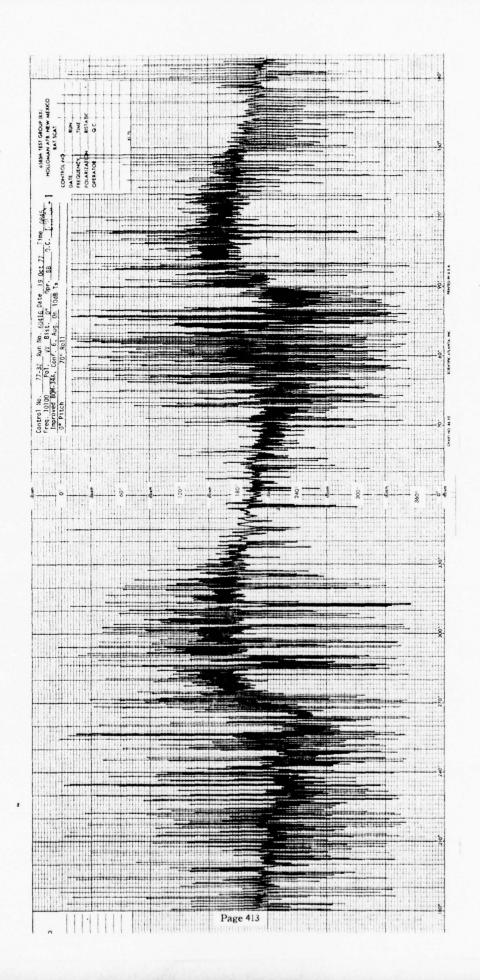


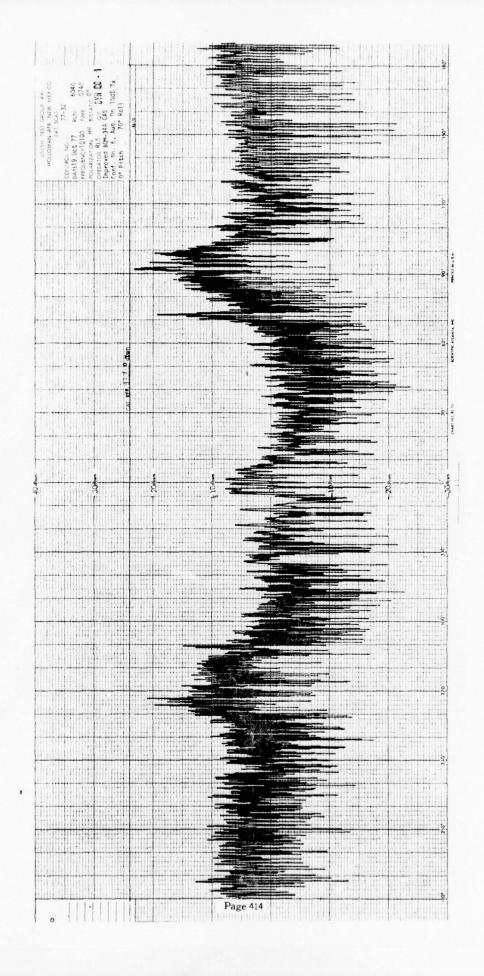


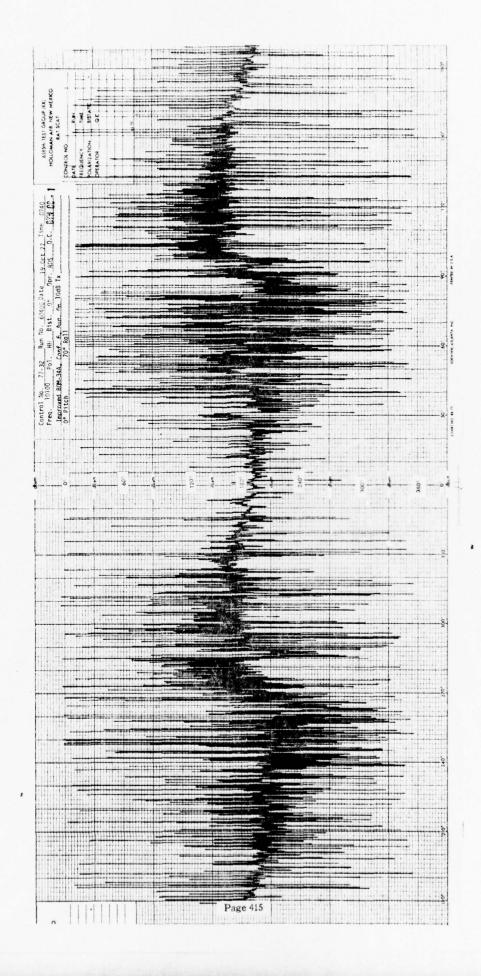


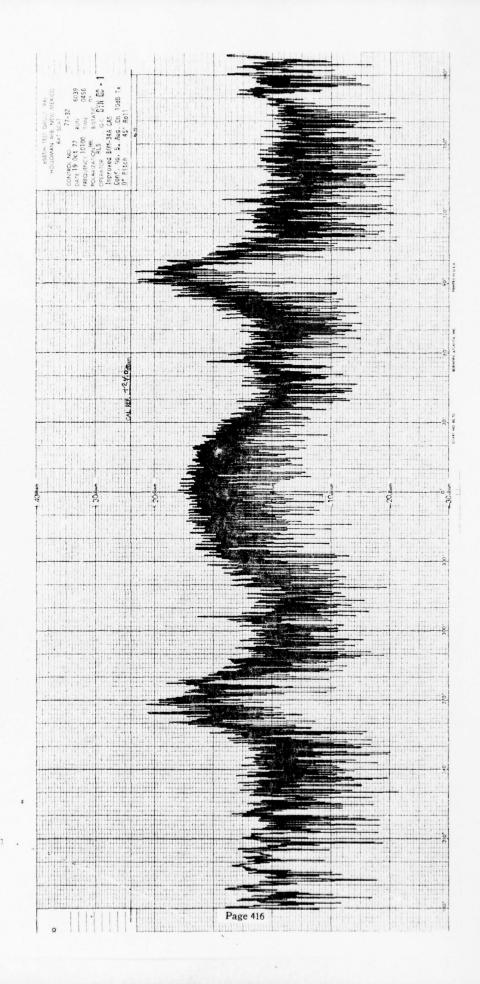


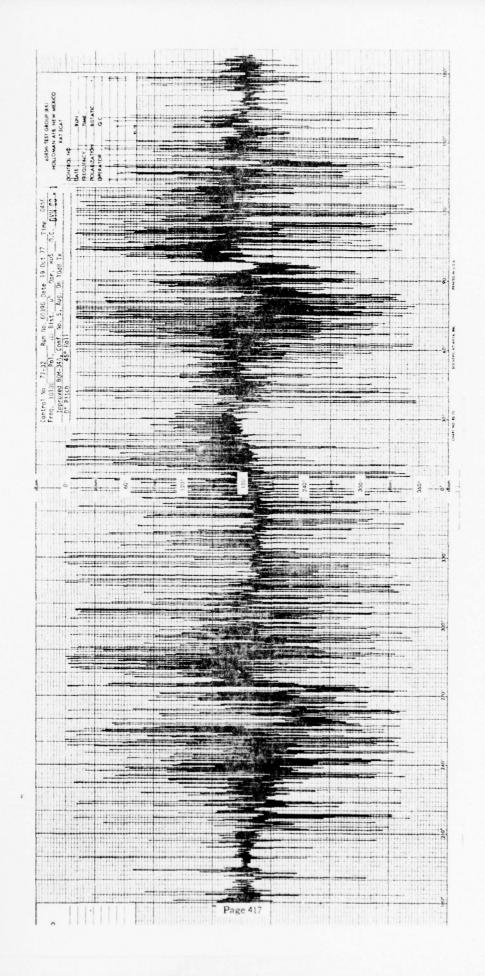


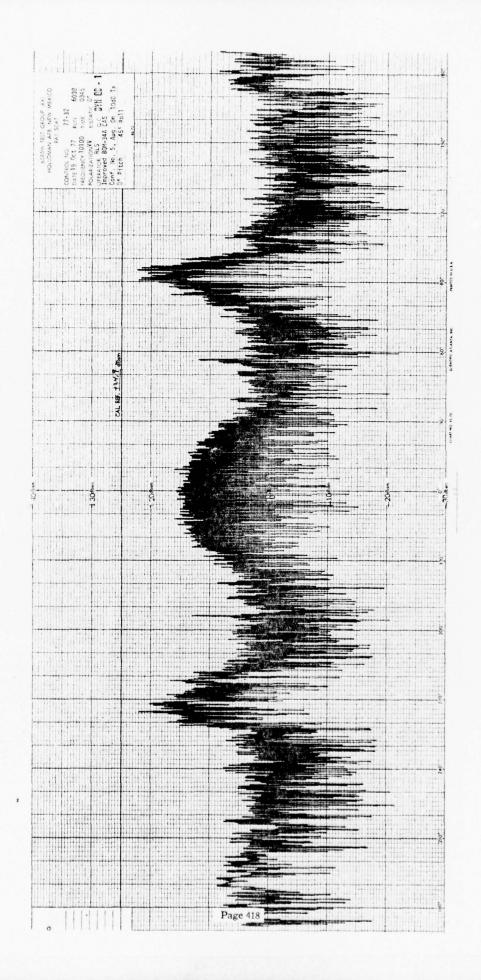


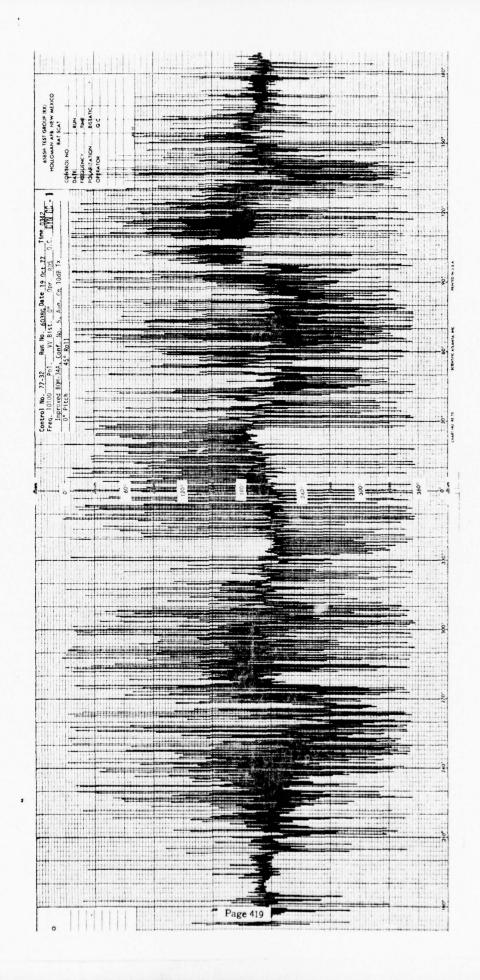


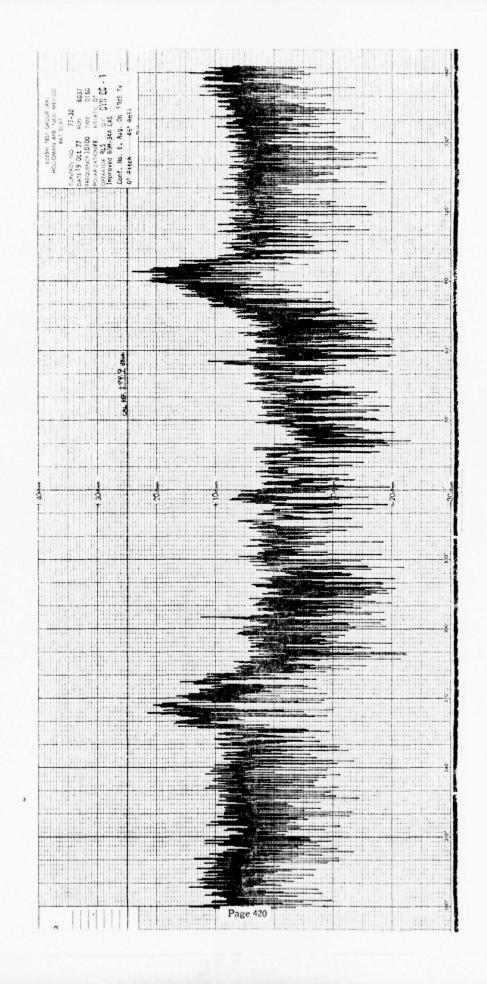


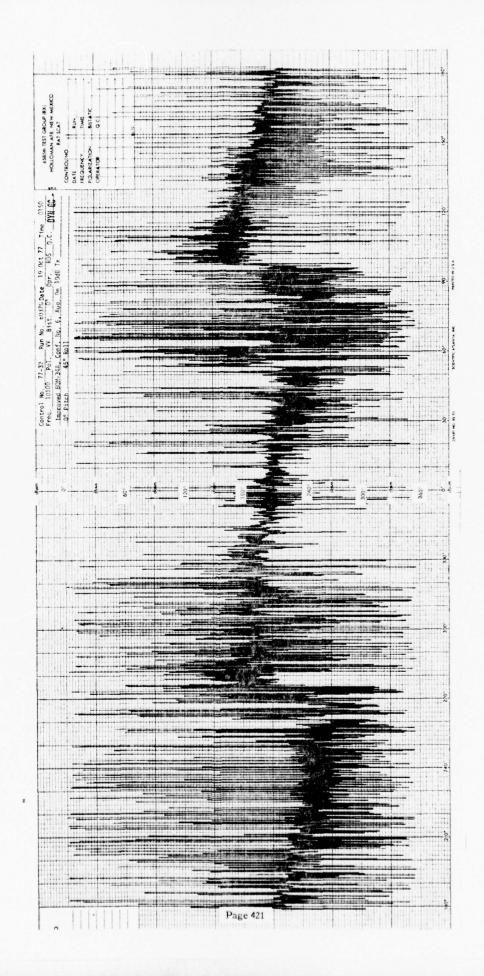


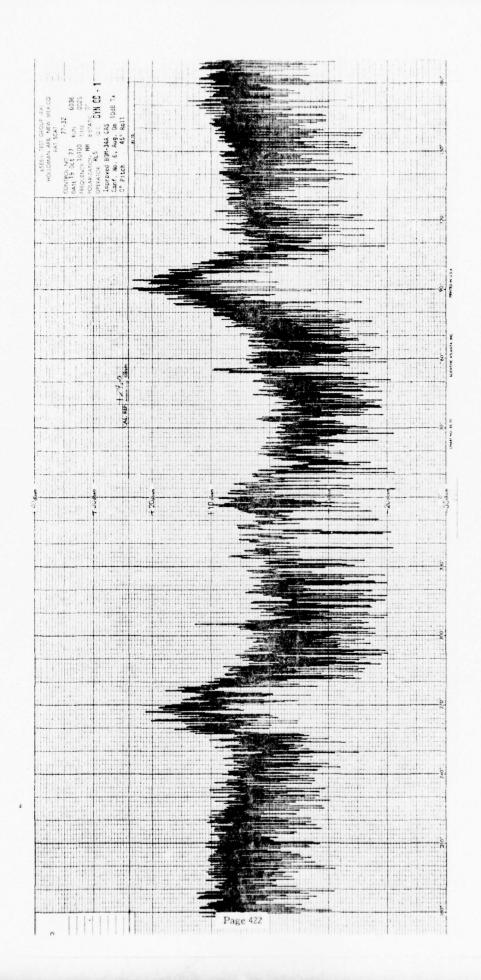


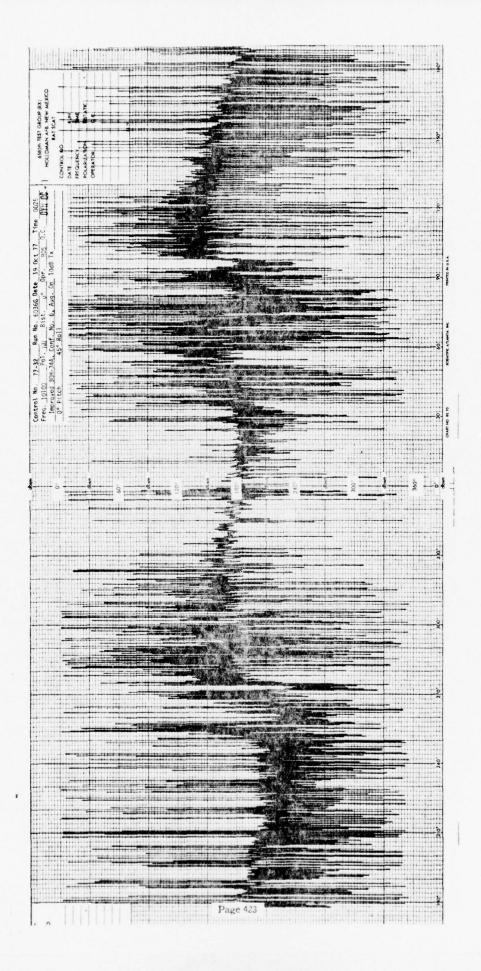


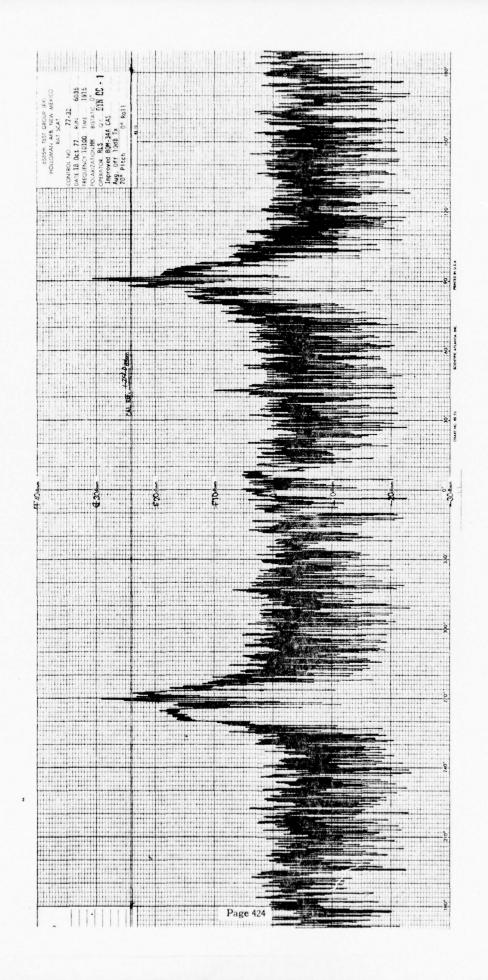


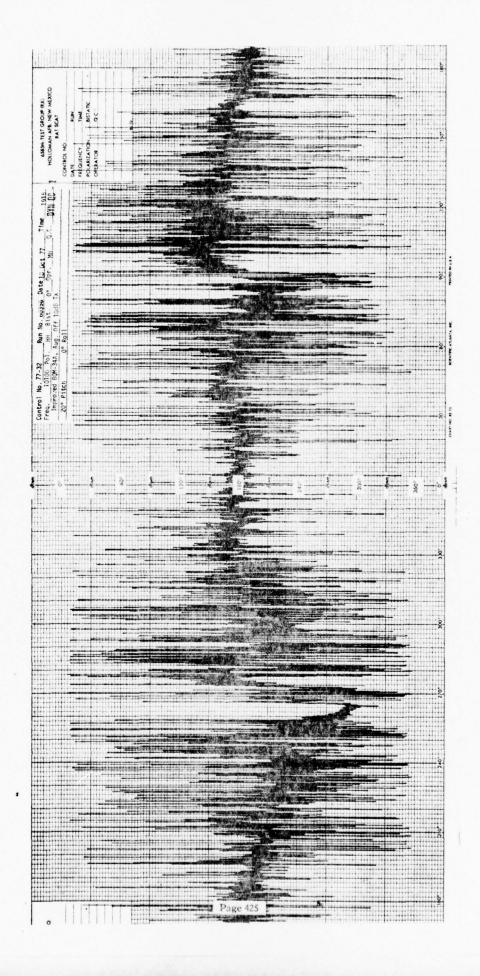


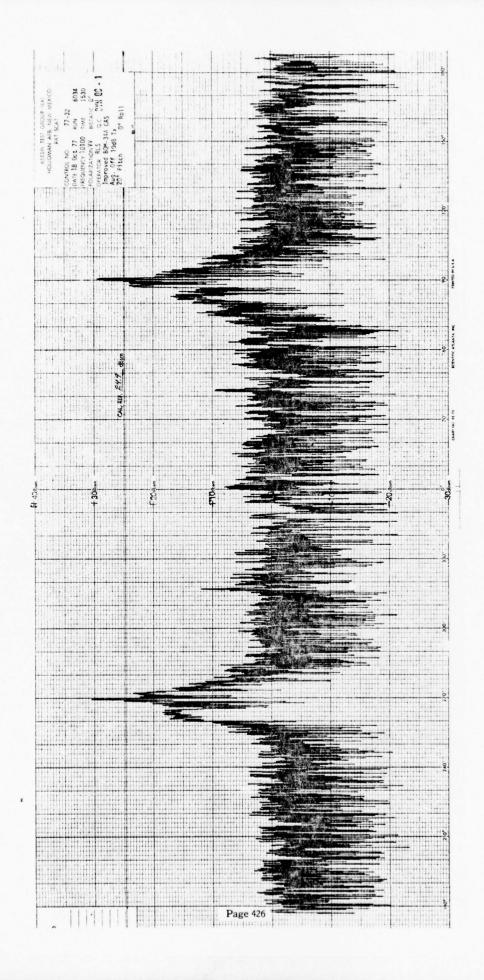


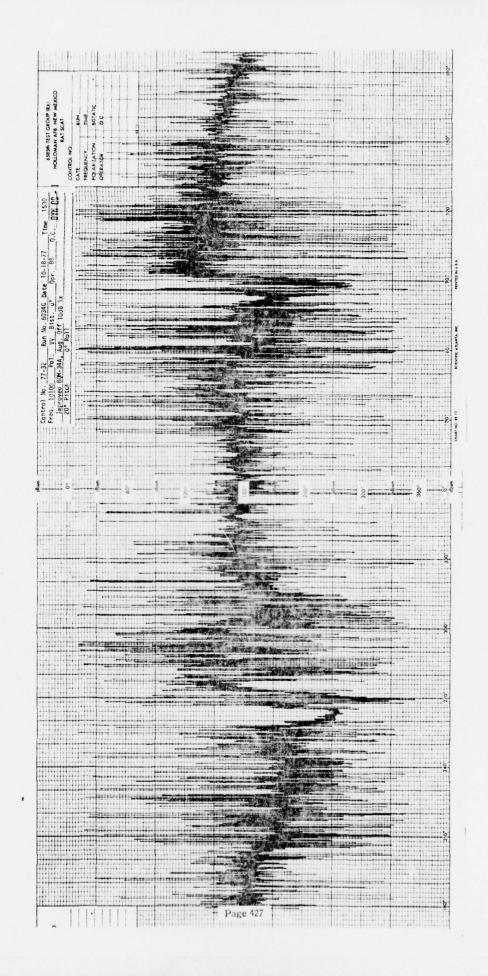


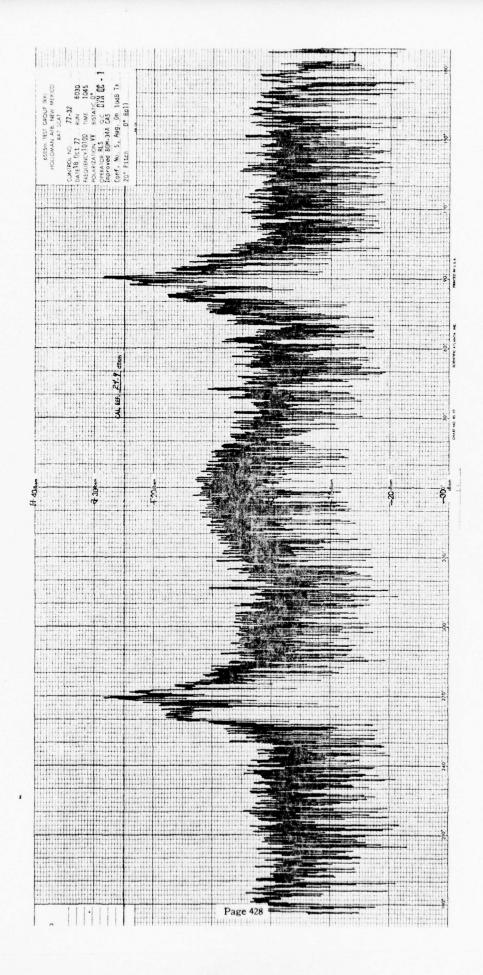


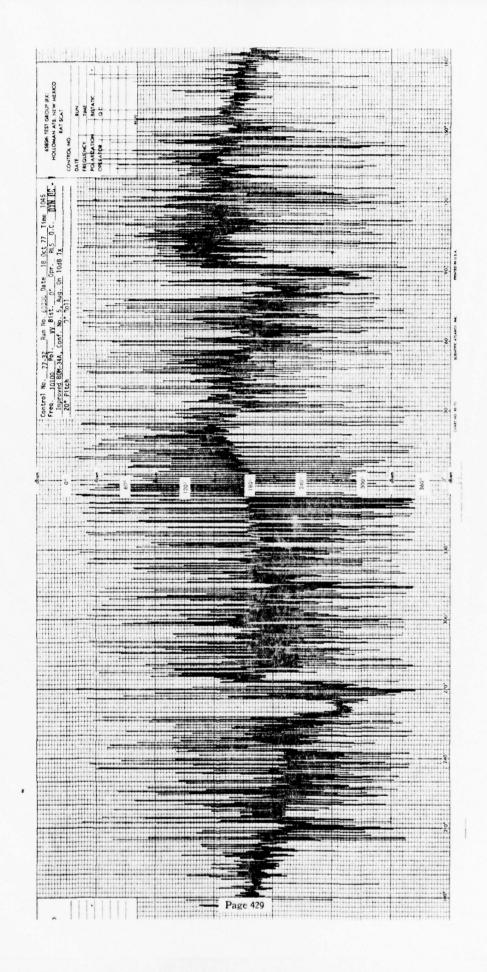


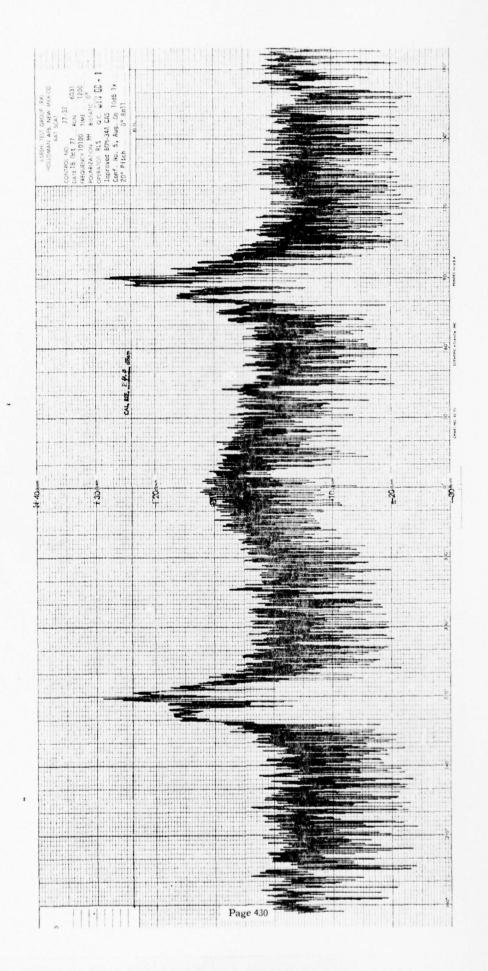


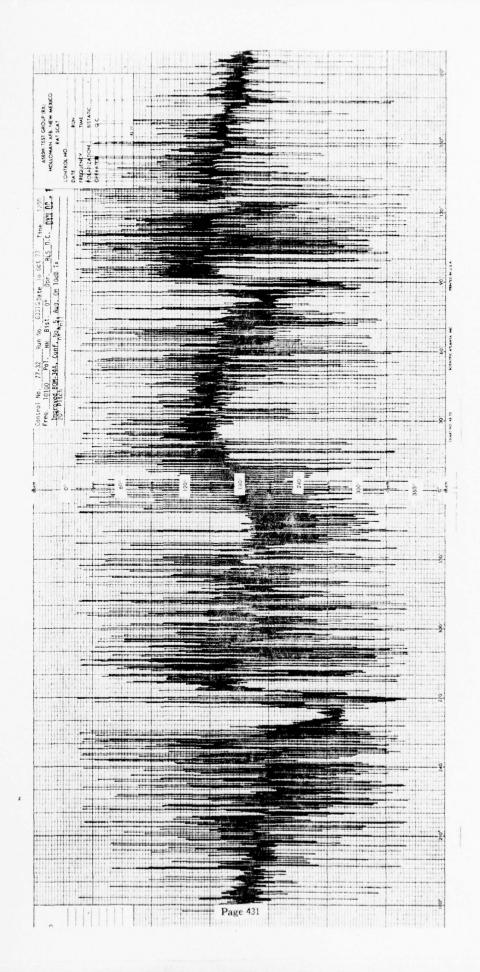


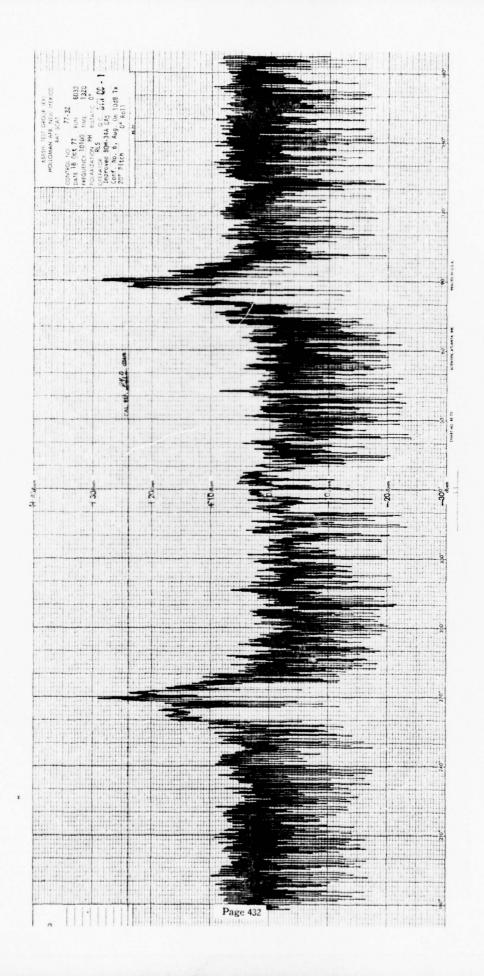


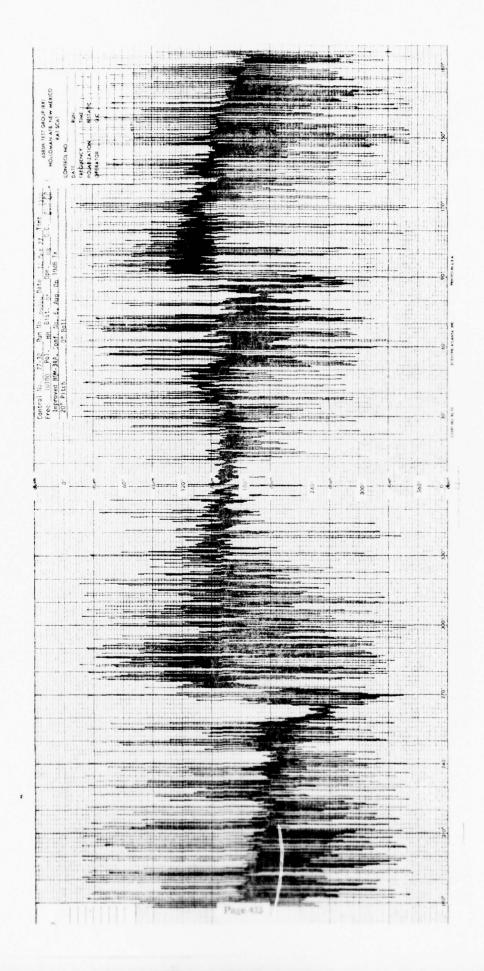


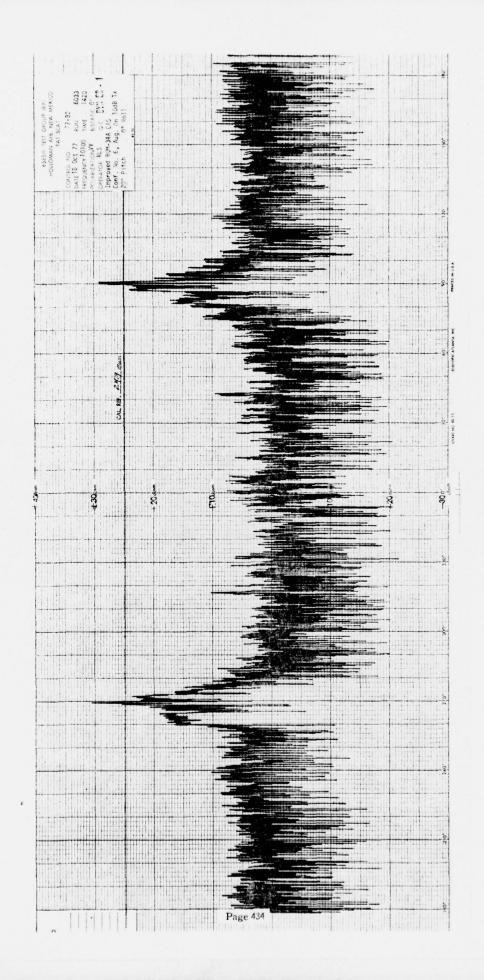


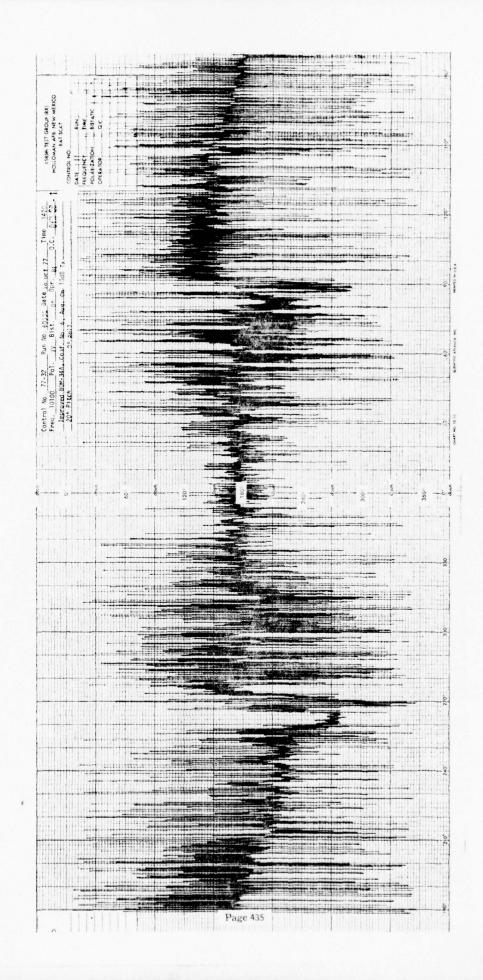


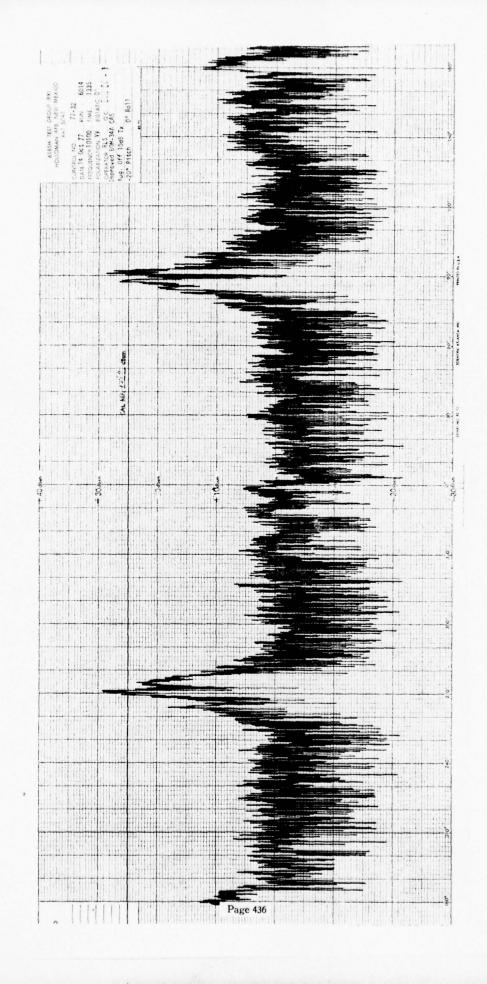


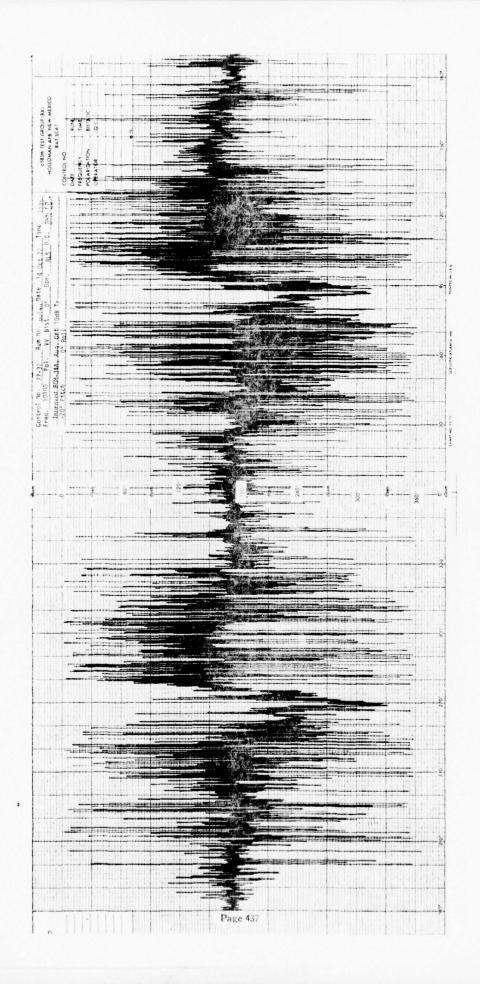


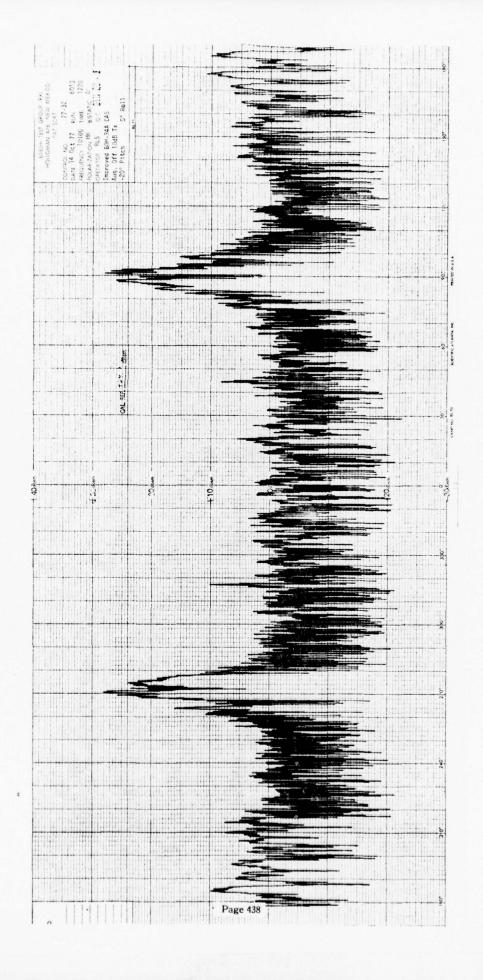


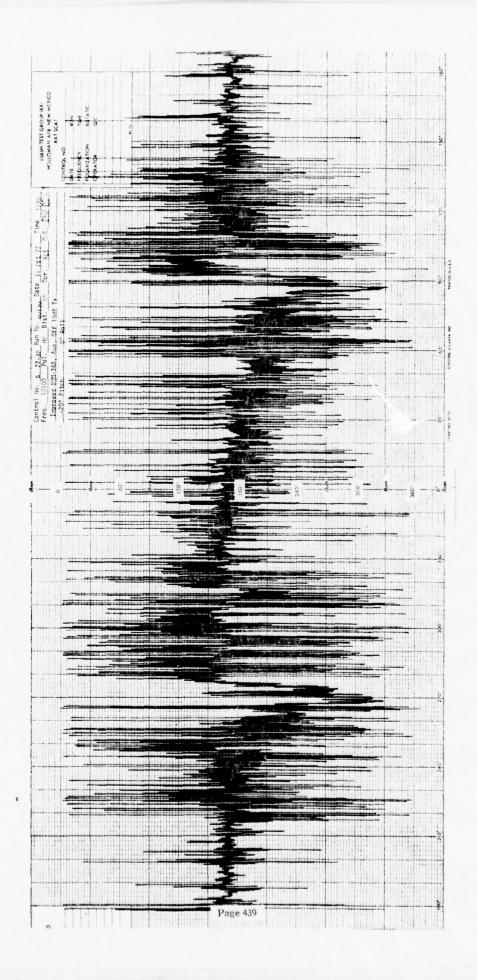


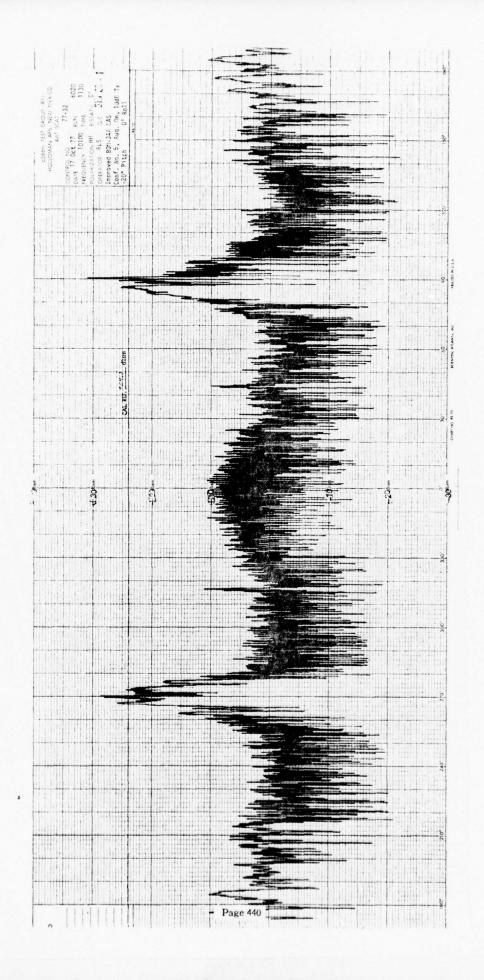


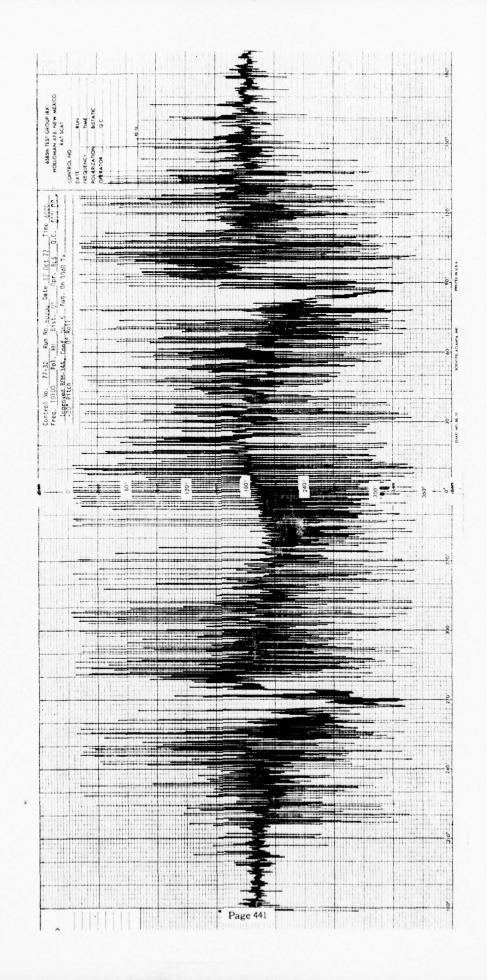


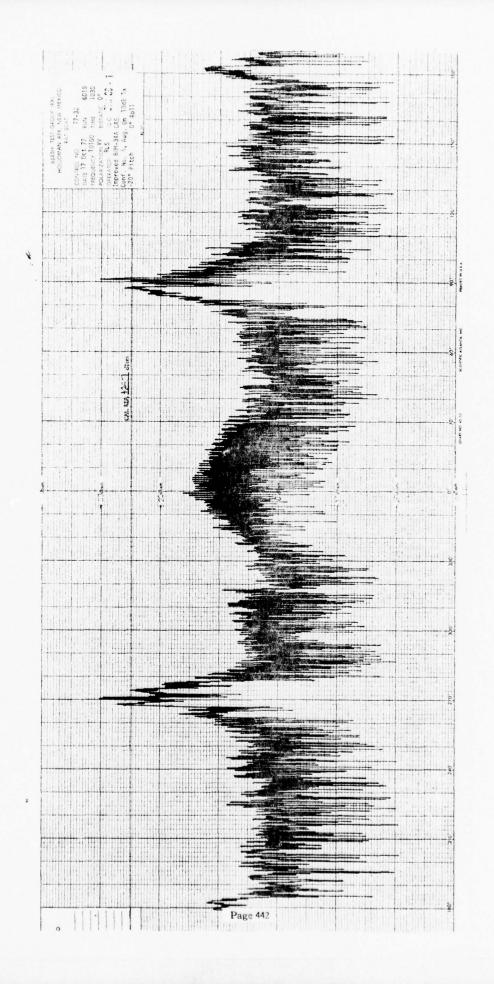


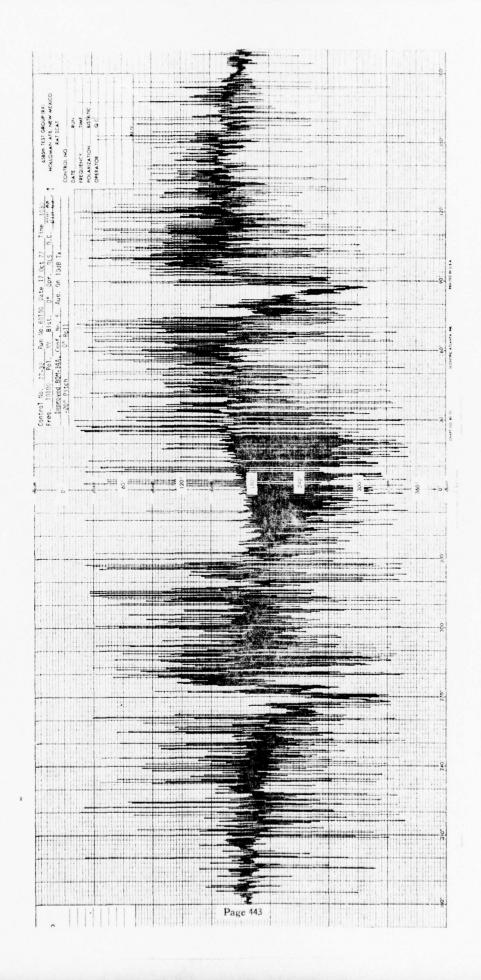


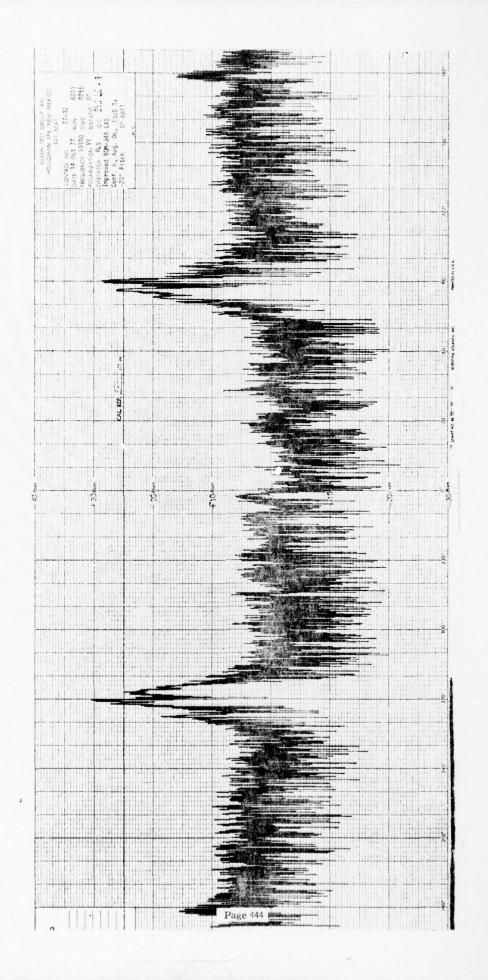


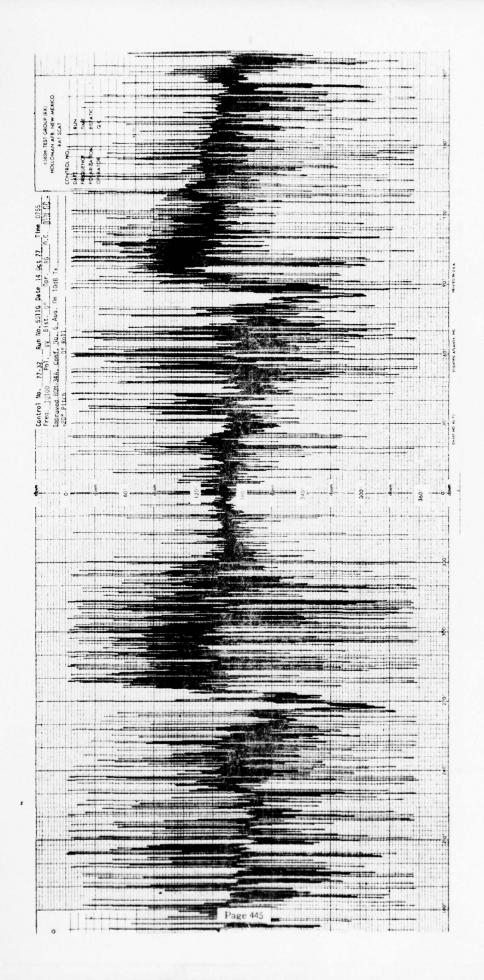


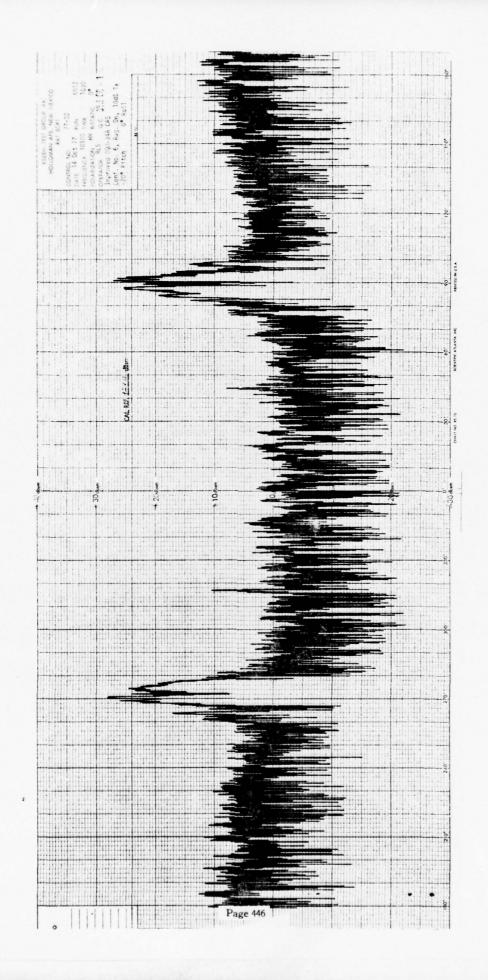


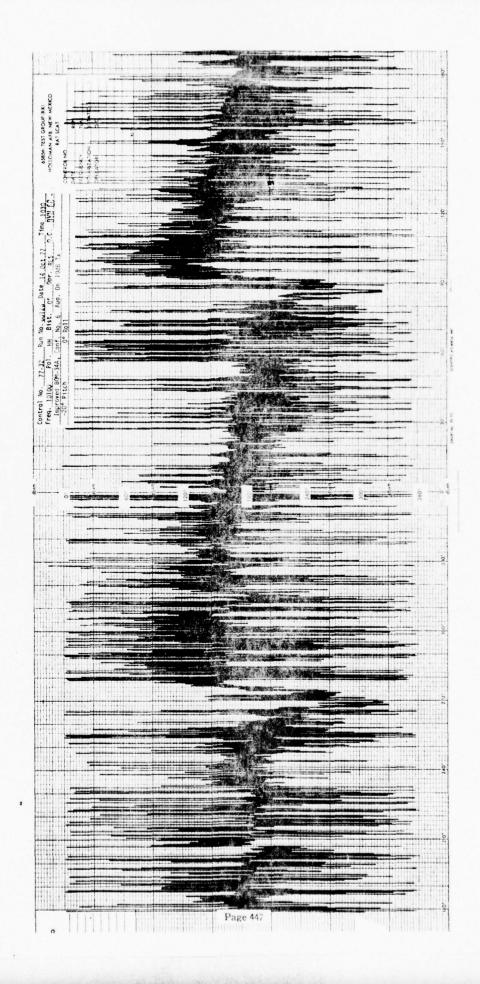












APPENDIX A SITE INTRODUCTION

1. GENERAL

RAT SCAT is a static ground plane radar cross section measurement site located on the Alkali Flats near Holloman Air Force Base, New Mexico. It is authorized by the DoD for use by governmental agencies. It is under the auspices of the 6585th Test Group, Armament Development Test Center, Eglin Air Force Base, Florida.

A ground plane range utilizes radar energy reflected from the earth as well as radar energy traveling directly to the target through the atmosphere. When the antennas and target are adjusted to proper heights, coherent phase addition of these electromagnetic waves into a flat wave front enhances the system sensitivity. Radar returns from objects near the earth's surface are reduced thus suppressing target area interference. Target area interference is reduced further through the use of special polyfoam support columns, radar absorptive materials (RAM), and rotators located below the earth's surface (in pits).

Pulsed transmitters are employed to enable utilization of the range gated receiving system, which can selectively measure radar returns from the target area or the range displaced transfer standard. Background interference outside the target range is eliminated by range gating. Operation without background cancellation is therefore practical.

2. CAPABILITIES

The RAT SCAT electronic equipment and controls are housed in a permanent building. Five separate range lengths (458 feet, 1150 feet, 1158 feet, 2458 feet and 5600 feet) are provided for range variation as shown in Figure A-1. This allows the use of convenient antenna and target heights while satisfying the far field criterion for most targets. Special 40-foot antenna towers are attached to the building for antenna height positioning. Further versatility is provided by two mobile equipment vans, one for monostatic range length variation and one for bistatic measurements. A summary of the RAT SCAT characteristics is contained in Table A-1.

CALIBRATION

The normal method of calibration at RAT SCAT is to mount a primary standard (precision sphere) scatterer with a known radar cross section

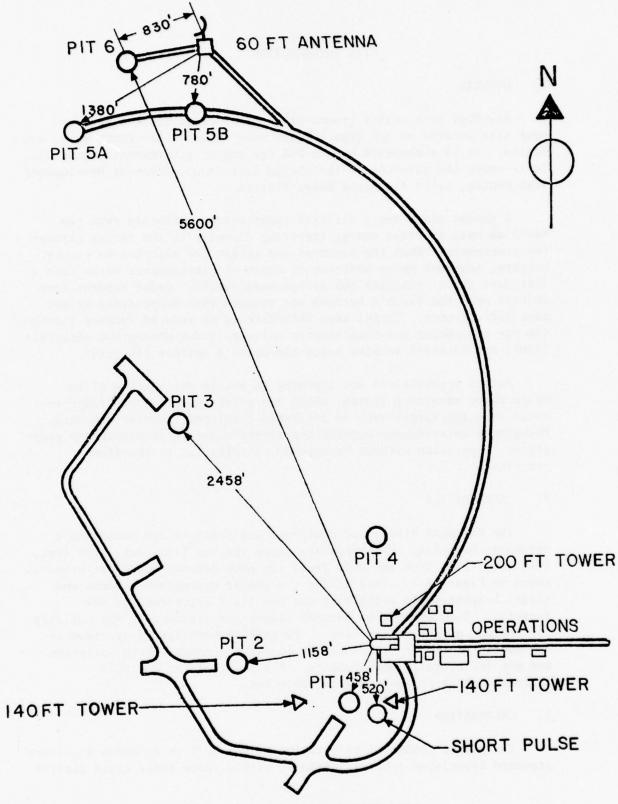


Figure A-1 MAP OF RAT SCAT SITE

TABLE A-1 RAT SCAT CHARACTERISTICS OF ELECTRONIC EQUIPMENT

Power Output 1 KW nominal bands 1 through 8, Special frequency bands, 50 to 120 KW.

Pulse Width 0.1 to 1.0 microsecond

Pulse Repetition Frequency 500 to 50,000 pps

Receiver Minimum -94 dBm nominal (-101 for 2 MHz IF Detectable Signal amplifier)

Receiver Bandwidth 2 or 10 MHz (selectable)

Range Gate Width 0.1 to 1.0 microsecond (50 to 500 feet)

Dynamic Range 70 dB

Linearity +0.5 dB

Equipment Stability 0.1 dB per hour (average)

Analog Data Format Polar and rectilinear plots of cross section, glint and phase vs. aspect angle

Digital Data Format 7 or 9 track magnetic (see Appendix C)

Antennas 1, 2, 3, 4, 5, 6, 8, 10 and 16 foot parabolic dishes (smaller and larger

dishes available for special tests)

Antenna Feeds Linear and circular horns with VSWR less

than 2.0 to 1.0

Polarization Horizontal, vertical, circular, ellip-

tical in any transmitting and receiving configuration, and continuously variable polarization, by special arrange-

ment.

TABLE A-1 (cont'd)

Azimuth Resolution

0.1 or 0.01 degree as applicable

Frequency Coverage

100 to 20,000 MHz continuous, 24, 35, 52 and 95 GHz

Band 0 - 50 to 100 MHz
Band 1 - 100 to 250 MHz
Band 2 - 250 to 500 MHz
Band 3 - 500 to 1000 MHz
Band 4 - 1000 to 2000 MHz
Band 5 - 2000 to 4000 MHz
Band 6 - 4000 to 8000 MHz
Band 7 - 8000 to 12,000 MHz
Band 8 - 12,000 to 20,000 MHz

24 GHz35 GHz52 GHz95 GHz

and record the corresponding signal level. Then the return from another secondary standard (corner or Luneberg lens) scatterer displaced in range is recorded as a transfer standard. Both the precision standard return and the transfer standard return are recorded on the same plot. Thereafter, radar cross section calibration is determined by referencing the transfer standard return for every run. Thus every run is recalibrated. The comparisons of primary and transfer standards accomplished before and after each measurement series are identified respectively as pre-calibration and post-calibration. If the direct ratio of primary to secondary readings is not maintained before and after the measurement series, then all runs between are invalid and must be repeated.

The calibration reference level marked on each data plot is related to the transfer standard level. This reference level may under controlled conditions differ from the actual transfer standard signal level since precision calibrated attenuation is sometimes inserted in the receiver line. When such attenuation is inserted, returns from the transfer standard are reduced to a level compatible with the scale used for the target measurements. The 70 dB dynamic range of the plot is placed to include the range of returns expected from the vehicle being measured. In some cases, two runs are necessary to be plotted for direct overlay to include the dynamic range of the vehicle if it exceeds 70 dB. Calibration plots are included with the target data when requested by the user.

In general, the background return is the vector sum of several scattering sources. These include support columns, transitions, pit openings and other obstacles located in the vicinity of the target. When the presence of the target does not appreciably alter the background return it is possible to obtain estimates of background induced errors. If the true target cross section is denoted by σ_T (square meters), background by σ_B , and the total measured cross section by σ_M , then as a function of azimuth angle

$$\sigma_{\rm M} = \sigma_{\rm T} + \sigma_{\rm B} + 2\sqrt{\sigma_{\rm T}\sigma_{\rm B}} \cos \phi$$
 A-1

In the above equation ϕ is the relative phase angle between target and background returns. Depending on the phase angle, the magnitude of $\sigma_{\!M}$ can vary between two extremes determined by whether the two signals are in-phase or out-of-phase (cos ϕ = +1). These two values of σ_{M} represent the maximum upper and minimum lower bounds on the possible variations of the total measured signal. From Equation A-1,

$$\sigma_{M(max)} = \sigma_{T} + \sigma_{B} + 2\sqrt{\sigma_{T}} \sigma_{B} = (\sqrt{\sigma_{T}} + \sqrt{\sigma_{B}})^{2}$$

$$\sigma_{M(min)} = \sigma_{T} + \sigma_{B} - 2\sqrt{\sigma_{T}} \sigma_{B} = (\sqrt{\sigma_{T}} - \sqrt{\sigma_{B}})^{2}$$

$$\Lambda = \frac{1}{2}$$

The maximum possible errors corresponding to the values of σ_M in Equation A-2 can be expressed in decibels as:

10
$$\log_{10} \frac{\sigma_{M(max)}}{\sigma_{T}} = 10 \log_{10} (\sqrt{\sigma_{T}} + \sqrt{\sigma_{B}})^{2} / \sigma_{T}$$

10 $\log_{10} \frac{\sigma_{M(min)}}{\sigma_{T}} = 10 \log_{10} (\sqrt{\sigma_{T}} - \sqrt{\sigma_{B}})^{2} / \sigma_{T}$

A-3

Graphs corresponding to these maximum error equations are shown in Figure A-2.

An estimate of the expected value of $\sigma_{\rm M}$ can be derived statistically by utilizing the "random phase" approach. This method yields an average value of $\sigma_{\rm M}$ between the two maximum error curves. In this case

$$\sigma_{M(av)} = (\sigma_T + \sigma_B)$$

and the corresponding error in decibels is given by:

10
$$\log_{10} \frac{\sigma_{\text{M(av)}}}{\sigma_{\text{T}}} = 10 \log_{10} (\sigma_{\text{T}} + \sigma_{\text{B}}) / \sigma_{\text{T}}$$
 A-5

This average error equation is shown graphically in Figure A-2.

The sphere calibration plots will not necessarily be straight lines. If the background return is within 20 dB of the sphere return, for example, a variation in sphere return of approximately +1 dB can result. For calibration the sphere is intentionally placed at least 1/2 wavelength off the center of table rotation to insure sufficient phasing with the background return. The average sphere return is then chosen for a calibration level.

4. OPERATING PROCEDURES

The following step-by-step procedure is standard in obtaining monostatic radar cross section measurements after frequency, feeds, antennas, antenna height, target height, and pit (range length) have been chosen:

- 1. Calibration As described in previous section.
- 2. Horizonta! and vertical probes (field strength measurements at the target area) Horizontal probes at the target area

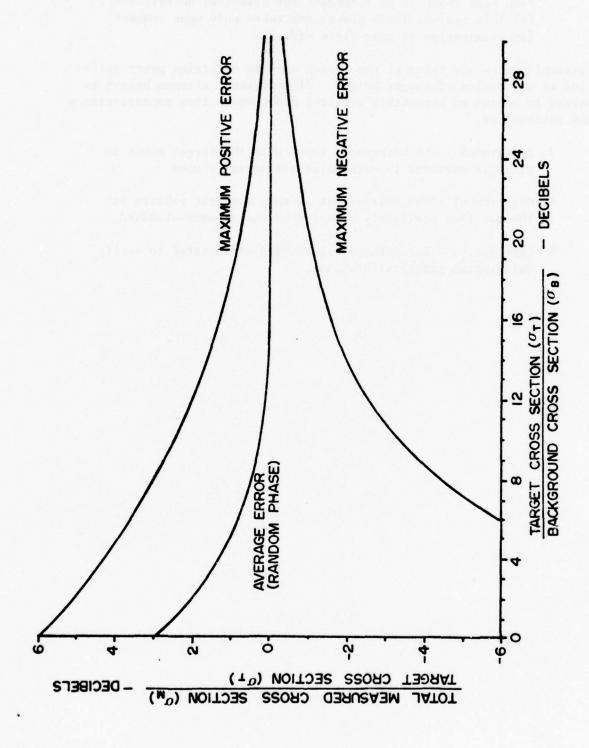


Figure A-2 Radar Cross Section Measurement Error as a Function of Target to Background Cross Section Ratio.

have been shown to be redundant for azimuthal boresighting. For this reason, these probes are taken only upon request for examination of near field effects.

Vertical probes are taken at the target area to determine power variation as a function of target height. If necessary, antenna height is varied to obtain an acceptable vertical probe which then necessitates a new calibration.

- 3. Background The background level with the target mount in place is measured in each polarization to be used.
- 4. Measurement The measurement is made with the vehicle in the position previously occupied by the primary standard.
- 5. Calibration The primary calibration is repeated to verify calibration (post-calibration).

APPENDIX B TARGET ORIENTATION AND DATA FORMAT

1. COORDINATE SYSTEM

The coordinate system described herein has been adopted as a standard for RAT SCAT operations. The system is referenced both to the vehicle being measured and to the measurement site.

a. Vehicle Reference

A three-axis system, referenced to an arbitrary vehicle, is illustrated in Figure B-1. In this system three mutually perpendicular planes (yaw, pitch, and roll) are passed through the vehicle so that the pitch and yaw planes mutually intersect on the longitudinal axis of the vehicle. These planes remain fixed with respect to the vehicle, regardless of vehicle rotation with respect to the radar or ground plane. The yaw plane, which includes the pitch axis and the roll axis, is numbered from 0 degrees to 360 degrees in a clockwise direction when the vehicle is viewed from the above. The nose-on aspect corresponds to 0 degrees, the starboard side of the vehicle corresponds to 90 degrees, and the port side to 270 degrees. The pitch plane, which contains the roll axis and the yaw axis is numbered from 0 degrees to +180 degrees; the +90 degree point is below the center line, and the -90 degree point is above the center line. The roll plane contains the yaw axis and the pitch axis. It is numbered from 0 degrees to 360 degrees, and the numbers increase in a counterclockwise direction when the vehicle is viewed from the rear.

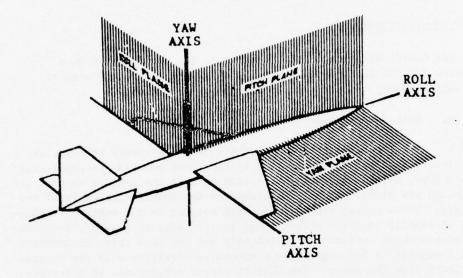
b. Site Reference

As previously stated the coordinate system is fixed with respect to the vehicle. It is referenced to the site by means of three index marks. The exact value of any of the three angles is determined by noting the value of the vehicle coordinate opposite the index marks. Index marks come from such devices as bubble levels, inclinometers and transits.

As illustrated in Figure B-2, the index for roll angles is normal to the axis of rotation. As illustrated in Figure B-3, the index for pitch angles is normal to the axis of rotation and in line with the apparent source of radiation. For measurements at the RAT SCAT Site, targets can be mounted to provide desired pitch and roll angles.

c. Coordinate System Tilt

For small targets another angle, tilt, can be utilized in recording useful data. This angle, equipment-limited to less than 15 degrees, is formed by the axis of rotation and the normal to the line of sight to



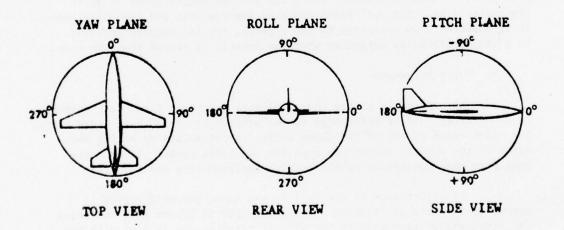
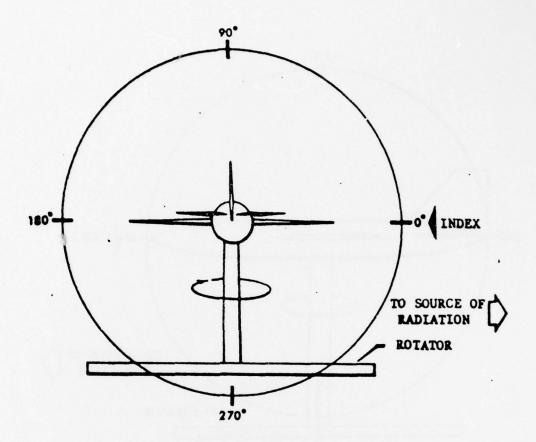


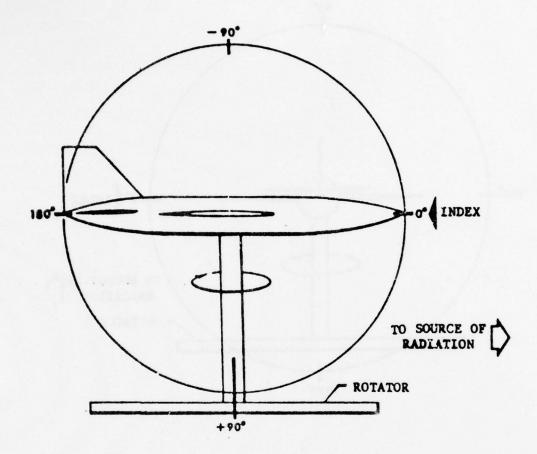
Figure B-1 VEHICLE COORDINATE SYSTEM



NOTE: The roll scale is fixed to the vehicle.

The amount of roll is determined by noting the number of degrees opposite the index. Clockwise rotation of the target (when viewed from the rear) increases the roll angle.

Figure B-2 TARGET ORIENTATION - ROLL



NOTE: The pitch scale is fixed to the vehicle.

The number of degrees of pitch is determined by noting the scale value opposite the index.

Figure B-3 TARGET ORIENTATION - PITCH

the apparent source of radiation. Since, in a ground plane range, radiation can be considered to emanate from a point with zero height directly beneath the antennas, a zero-degree tilted axis of rotation is slightly off the geometrical vertical. This small deviation from the geometrical vertical is neglected in the following discussions.

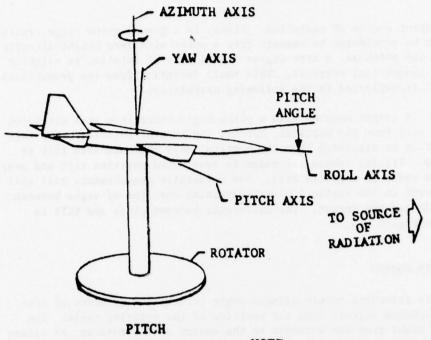
A target mounted with a pitch angle other than zero displaces the yaw axis from the vertical, but not the axis of rotation. The axis of rotation is displaced from the vertical only when non-zero tilt is employed. Tilting toward the radar is considered positive tilt and away from the radar is negative tilt. For monostatic measurements tilt will be measured in the vertical plane containing the line of sight between the radar and the target. The difference between pitch and tilt is shown in Figure B-4.

2. DATA FORMAT

Data recorders obtain azimuth angle information by means of precision synchro signals from the position of the rotating table. The line of sight from the antennas to the center of the rotator, as illustrated in Figure B-5, indexes azimuth angles. As used here the term aximuth refers to the position of the target rotator table. With zero degrees of pitch and roll, azimuth and yaw are identical. It is standard practice to turn the rotator in a clockwise (cw) direction as viewed from above. Consequently, the aximuth angle varies, for example from 180 degrees (tail-on) to 90 degrees (starboard-side) to 0 degrees (nose-on) to 270 degrees (port-side).

a. Polar and Rectilinear Plots

Essential information pertinent to each plot is contained in the information block located in the upper right hand corner of the rectilinear plots and in the second quadrant of the polar plots. Each rectilinear plot has the recording of the return from the left side of the vehicle on the left side of the plot, 0 degrees at the center, and the recording of the return from the right side of the vehicle on the right side of the plot; 180 degrees (tail-on) appears at the right and left extremeties of the plot, as shown in Figure B-6. Since the paper moves from left to right under the recorder pen, it should be noted that measurements are limited at 180 degrees in order to obtain continuous measurements on the recorder paper. The table on the polar recorder is rotated in the same directions as the target so the 90 degree point appears on the right side of the polar plot, the 270 degree point on the left, and the zero or 360 degree point at the top of the plot.



NOTE:

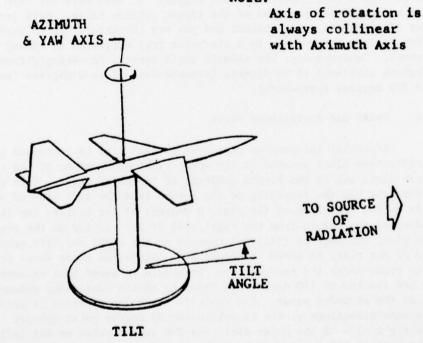
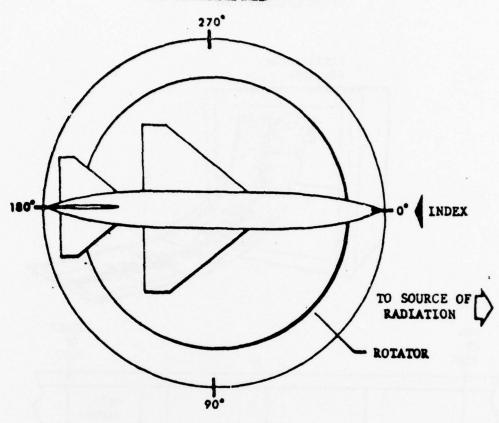


Figure B-4 COMPARISON OF PITCH AND TILT ORIENTATIONS

B-6



NOTE: The azimuth scale is fixed to the target rotator. The azimuth value is determined by noting the value of the scale opposite the index mark as the rotator and scale revolve. The index is the line-of-sight from the radar antennas to the center of the rotator. (Azimuth angle data are transmitted to the data recorders by means of synchro signals.) The standard direction of rotation will be clockwise.

Figure B-5 TARGET ORIENTATION - AZIMUTH

B-7

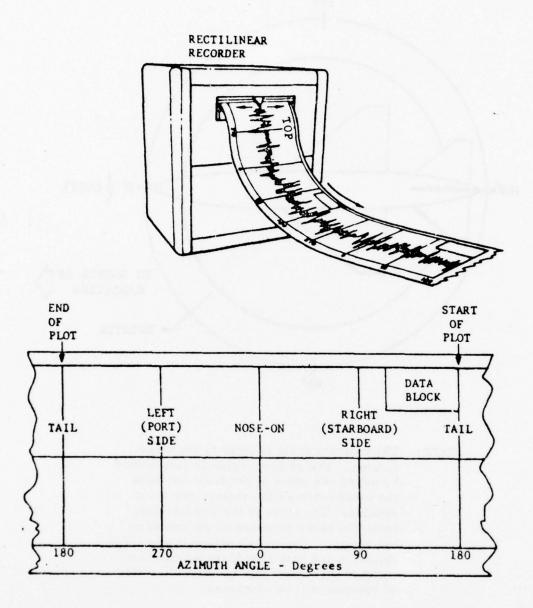


Figure B-6 FORMAT FOR RECTILINEAR PLOTS

B-8

Appendix C DIGITAL DATA FORMATS L, M AND N

A. General

Digital data tapes are normally 9-track, 800 BPI in one of three formats. The three formats are similar except for the presence or absence of a second dependent variable which is either phase or bistatic RCS amplitude.

Format	Type Data
L	Azimuth and Monostatic RCS
M	Azimuth, Monostatic RCS and Bistatic RCS
N	Azimuth, Monostatic RCS and Phase (or Glint)

Tapes are written in BCD Card Image. The number of records depends on the azimuth increment.

B. File Structure

A tape may contain several runs. Each run is a File and is followed by an end-of-file mark. Two or more end-of-file marks are placed after the last run.

A run (file) will consist of:

- 1. Standard RAT SCAT header
- 2. Special customer specified header
 - 3. Data files
 - 4. End-of-file

C. Record Structure

 Standard RAT SCAT header (*ID Record) FORMAT (4(I4, 4X), 24A2)

Character	Format Description	
1 - 4	14	Control Number
5 - 8	4X	Blank
9 - 12	14	Run Number
13 - 16	4X	Blank
17 - 20	14	Bottom Scale 1
21 - 24	4X	Blank

Charac	Character		Format			Description	
25 -			14	4		Bottom Scale 2	
29 -	29 - 32		4X			Blank	
33 -	33 - 80		24A2			Process ID	
Examp	le:						
7611	1234	-300	-200	RAT	SCAT	(in-house information)	

* 2. Special customer specified header - format and contents negotiable.

3. Data Files

a. L Format

(3(F7.2, F5.1X), 1X, 3(F7.2, F5.1, 1X), 1X)

Characters	Item	Format	Value
1 - 7	Azimuth (Degrees	F7.2	180.00
8 - 12	RCS (dBsm)	F5.1	016.2
14	Blank	1X	
15 - 21	Azimuth	F7.2	179.99
22 - 26	RCS	F5.1	-15.3
27	Blank	1X	
28 - 34	Azimuth	F7.2	179.98
35 - 39	RCS	F5.1	-14.4
40	Blank	1X	
41	Blank	1X	
42 - 48	Azimuth	F7.2	179.97
49 - 53	RCS	F5.1	-13.5
etc.			
b. M Format			

(4(F7.2, F5.1, 1X, F5.1, 2X))

Characters Item Format Value 1 - 7 Azimuth (Degrees) F7.2 180.00 8 - 13 RCS 1 (dBsm) F5.1 -15.114 Blank . 1X 15 - 19 RCS 2 (dBsm) F5.1 -21.3 20 - 21Blank . 2X

Characters	<u>Item</u>	Format	Value	
22 - 28	Azimuth	F7.2	179.98	
29 - 33	RCS 1	F5.1	-16.4	
etc.				

c. N Format

(4(F7.2, F5.1, 1X, F5.0, 2X))

Characters	<u>Item</u>	Format	Value
1 - 7	Azimuth (Degrees)	F7.2	180.00
8 - 13	RCS (dBsm)	F5.1	-16.4
14	Blank	1X	
15 - 19	Phase (Degrees)	F5.0	+153.
20 - 21	Blank	2X	
22 - 28	Azimuth	F7.2	179.99
29 - 33	RCS	F5.1	-15.2
34	Blank	1X	
35 - 29	Phase	F5.0	+148.
etc.			

Note: Seven-track tapes of 200, 556 or 800 BPI may be obtained upon request.

D. Deviations

Some projects will require special formatting, i.e., short pulse, FFT applications. Applicable addenda to this appendix will be published accordingly.

APPENDIX D

GLINT MEASUREMENT

Glint is the apparent cross-range displacement of the phase center of a radar target. The apparent displacement is derived from measurement of the phase difference across a known baseline interpreted with respect to the constant factors of baseline length, measurement range, and wavelength at the measurement frequency. The relationships used for the computation of cross range deviation from the boresight axis of an interferometer can be derived from the geometry associated with the measurement system. The RAT SCAT glint measurement system geometry is illustrated in Figure 4.

The relative phase of the signal received by the antenna system is proportional to the distance traversed and can be expressed as a function of the direction angle β , baseline length S, and range r.

For Antenna No. 1 the phase of the signal received is proportional to the path length P_{1}

$$P_1 = \left[r^2 + \left(\left(\frac{S}{2}\right)^2 + Sr \cos \beta\right)\right]^{\frac{1}{2}}$$

Similarly for the signal at Antenna No. 2

$$P_2 = \left[r^2 + \left(\left(\frac{S}{2}\right)^2 - Sr \cos \beta\right)\right]^{\frac{1}{2}}$$

Expanding by the binomial theorem and truncating terms of order greater than \mathbf{r}^{-3}

$$P_1 = r + \frac{S}{2} \cos \beta + \frac{S^2}{8r} - \frac{S^2 \cos^2 \beta}{8r} - \frac{S^3 \cos \beta}{16r^2} - \frac{S^4}{128r^3} +$$

$$\frac{S^3 \cos^3 \beta}{16r^2} + \frac{3S^4 \cos^2 \beta}{64r^3}$$

and

$$P_2 = r - \frac{s}{2} \cos \beta + \frac{s^2}{8r} - \frac{s^2 \cos^2 \beta}{8r} + \frac{s^3 \cos \beta}{16r^2} - \frac{s^4}{128r^3}$$

$$\frac{S^3 \cos^3 \beta}{16r^2} + \frac{3S^4 \cos^2 \beta}{64r^3}$$

Subtracting

$$P_1 - P_2 = S \cos \beta - \frac{S^3 \cos \beta (1 - \cos^2 \beta)}{8r^2}$$

or

$$\cos \beta = \frac{P_1 - P_2}{s} + \frac{s^2 \cos \beta (1 - \cos^2 \beta)}{sr^2}$$

For S << r, the ommission of the contribution due to the second term in the expression for $\cos \beta$ produces a negligible error and consequently can be ignored and

$$\cos \beta = \frac{P_1 - P_2}{S}$$

where

 P_1 - P_2 is the phase difference at the receiving antennas S is the baseline length in degrees at the measurement frequency

The cross range displacement can be determined from the expression

$$D = R \cot \alpha \beta$$

or rewritten in terms of cos ß

$$D = \frac{R \cos \beta}{(1 - \cos^2 \beta)^{1/2}}$$

For a cross range displacement of 50 feet, the contribution of the factor $\frac{1}{(1-\cos^2\beta)^{1/2}}$ is less than 0.1 feet and for the case of D << R,

In terms of the measurement system parameters the apparent cross range displacement (D) due to target glint can be expressed as

$$D = \frac{\phi R \lambda}{360S}$$

where

φ = phase difference in degrees

R = measurement range

 λ = wavelength at the measurement frequency

S = physical baseline length.

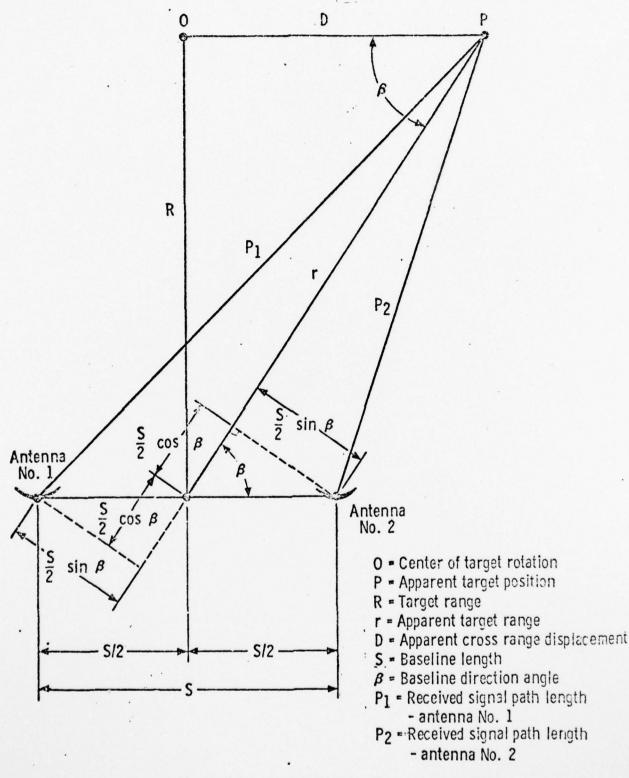


Figure D-1. RAT SCAT Glint Measurement Geometry

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